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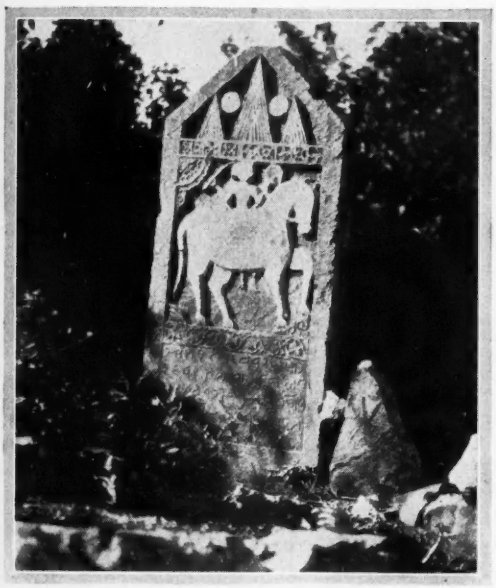
## A Monthly Popular Journal of Knowledge

Vol. XI. No. 130. OCTOBER, 1930. PRICE 1s. NET



TO A VILLAGE HERO
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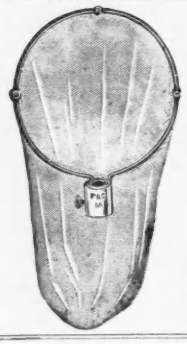

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# DISCOVERY

A Monthly Popular Journal of Knowledge

Vol. XI. No. 130. OCTOBER, 1930. PRICE 1s. NET

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## Editorial Notes.

The publication of our September issue coincided with the news that the remains of Andrée, the Norwegian explorer, had been discovered in the Arctic ice, thirty-three years after his fatal balloon expedition. The body was found on Kvito Island by a Norwegian party while exploring Franz Josef Land this summer, and was identified by initials on the clothing. The remains of his companions, Strindberg and Frankel, were also discovered in what was evidently their last camp. Most important of all, the finds included Andrée's diary and log book, the diaries of Strindberg and Frankel, and a roll of films. Extracts from Strindberg's notebook have already been published. The contents of Andrée's diary also throw light on the fate of the explorers, hitherto a complete mystery. From the preliminary reports printed in *The Times* by Dr. Gunnar Horn, it appeared that Andrée may have lived for at least two months after the wreck of his balloon. In view of later investigation, it is thought that the explorers may have survived for a much longer period, although the actual duration is not known. Andrée and his companions were, apparently, carried on ice-floes to the scene of their death before being overcome by cold and exhaustion. To readers of *Discovery* the conjecture that the explorers survived for so long is of special interest, for the possibility of "living off the country" in the Arctic was supported in our columns by no less an authority than Sir Hubert Wilkins. The question has, of course, been long disputed by explorers, the majority maintaining that to live by hunting is not usually practicable in the Arctic regions. The stoutest advocate of the opposite view is Vilhjalmur Stefansson, who claimed to have lived by this means for a period of six weeks after his provisions had become exhausted. Among the attacks which unfortunately characterized Amundsen's biography, none was more scathing than the scorn poured upon this achievement, Stefansson being bluntly accused of fabrication. It was then that Sir Hubert Wilkins wrote to *Discovery* (January, 1928) in defence of his fellow-explorer, confirming the view that the pack-ice is by no means so hostile to human existence as is generally supposed.

* * * * *

Polar exploration lends itself to controversy more than any other science. This must necessarily be the case as so often the exact results of exploration perish with their authors. Andrée's diary may help to solve the pack-ice question. But whatever it finally reveals, everyone will rejoice that this Norwegian pioneer was found by fellow-countrymen while engaged many years later in the same task of exploration. The simple but impressive reception which met the party at Tromsö was a fitting end to Andrée's career. The writer of these notes can well picture the scene, as he happened to visit this northern fishing town in 1928 when the search for Amundsen was in progress. The Italian seaplane which joined in the search had just stopped in the harbour on its northward journey, and the same feelings of sympathy and comradeship were reflected in the faces of all the inhabitants, most of them fishermen engaged themselves in whaling and in the polar seal trade.

* * * * *

Following the discovery of the Andrée remains is the news that relics have been found of the camps of Sir John Franklin, the explorer, whose expedition to the Arctic perished in 1847. The discovery has been made by Major L. T. Burwash, the Canadian

Government geological explorer, who has just returned to Edmonton, Alberta, after making the first airplane flight to the district of the North Magnetic Pole. Franklin had set out to find the north-west passage, and was last heard of in Baffin Bay in the spring of 1845. Thirty-nine expeditions were made in the ten years following his disappearance in the hope of finding traces, but it was not until fourteen years later that a record of the expedition was found at Point Victory which clearly showed that Franklin had died in 1847, after the object of his expedition had been achieved. In 1860 another search was made which proved fruitless, but sixty-six years later a skull and some remains of sailor's uniform were found. The contents of the documents now discovered have not yet been revealed by Major Burwash, who is retaining them for the purpose of making an official report to the Canadian Government. Among the relics are a sailor's jacket of the style worn in the early part of last century, a pair of bearskin trousers and a portion of a tent.

* * * * *

The failure of Professor Peccard's first attempt to ascend to a height of fifty-two thousand feet in a balloon, which is fitted as a physical laboratory, has not discouraged this enterprising Swiss scientist from contemplating a second attempt. Unsuitable weather made the ascent impossible, and Dr. Peccard and his assistant are now awaiting more favourable conditions. The professor's aim is the study of the conditions of the upper atmosphere, and the balloon, which is constructed of aluminium and is ninety-eight feet in diameter, is hermetically sealed and has been designed to resist enormous atmospheric pressure. Half of the aluminium ball is painted black, and if the internal atmosphere becomes too cold, the painted half may be turned to the sun so that it may absorb the heat more readily. If, on the other hand, the temperature becomes over-heated, the aluminium surface will be turned to the sun. Whether Dr. Peccard's experiment will meet with success has yet to be shown ; the last attempt to ascend to an altitude of more than 45,500 feet ended in disaster some years ago for an American scientist. At any rate, the professor will be wished the success which his laborious preparations deserve, and the result of his second attempt will be awaited with interest.

* * * * *

This month the Royal Geographical Society celebrates its centenary, and on 21st October the Duke of York, on behalf of the King, will officially open the Society's new buildings, which include an imposing hall and library. Delegates from many of the leading geographical societies of the world are to attend the celebrations, and an important feature will be a reception on the following day in the Society's building at Kensington Gore, when the overseas geographers will be entertained by the President, Council and Fellows of the Society. A series of addresses dealing with the Society's history are to be given at the centenary meeting in the new hall on the evening of 21st October. It is announced that the Prince of Wales has accepted an invitation to preside at the centenary dinner which will be held at the Connaught Rooms on the evening of 23rd October. Incidents in the history of exploration and the subject of the Hospitable Globe will form topics of discussion at meetings on 22nd and 23rd October in which members of the Society and overseas guests will take part.

* * * * *

The digging of a gravel pit at Brown Candover, a village near Winchester, has revealed what is thought to be a Bronze Age urn field. Three burial urns, each containing human remains, have been discovered and are being sent to the British Museum for reconstruction and acceptance. These interesting discoveries are described in a letter to *The Times* from Mr. S. E. Winbolt to whom the urns have been entrusted. Cremation and urn-deposit, he writes, are characteristic of the Bronze Age in this country, but mound burials are more common than cemetery burials. The first urn, recovered in many fragments, but largely reconstructed, is of poor clay, imperfectly baked, red outside and black inside. The cordon is vertically incised at intervals with a stick or bone.

* * * * *

Sir Arthur Keith, who examined the remains, thinks that they are the remains of a young adult, the bones of the skull being still unjoined—a woman rather than a man. The second find is a food vessel used as an urn. The collar above the cordon is ornamented with transverse discrete lines composed of long scratches, first right, then left, with vertical lines. The material of this pot, hand-made like the others, is coarse clay mixed with particles of chalk, and burnt bright red nearly through. The third is a big urn, the considerable contents of which have not yet been examined. The ornament above the cordon and below an encircling line under the rim is of chevrons incised in a jagged manner, probably with the broken end of a bone. About half the pot held together round the contents and the rest was in forty to fifty fragments. No ornaments were found in any of these urns, but there were pieces of charcoal and burnt flint. It is not known in what position, upright, inverted, or on the side, they were buried.

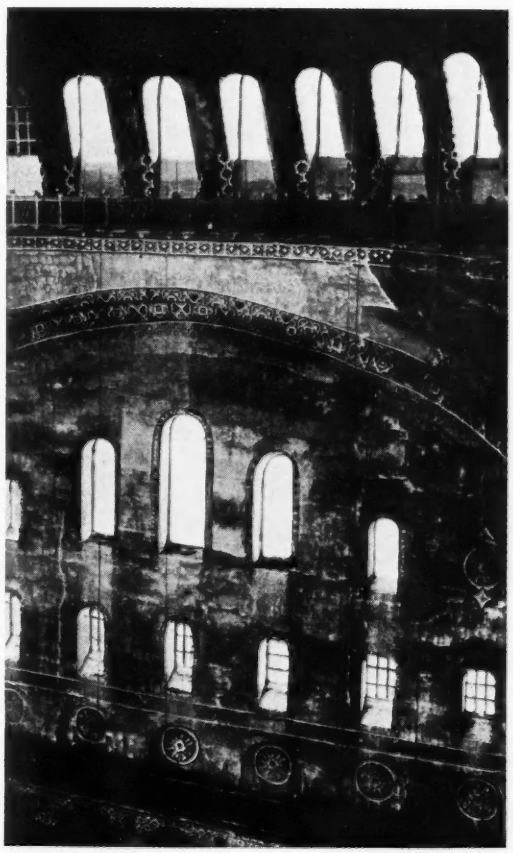
# Saint Sophia Revisited.

**By Stanley Casson, M.A.**

*A remarkable feature of the Church of Saint Sophia is that hardly an archway is symmetrical and hardly a line is straight. Mr. Casson recently examined the building and discussed the matter at length with the architect in charge of repairs. He here reveals for the first time the cause of the distortions.*

ST. SOPHIA is remarkable in so many ways that one tends to forget some of the most noteworthy while one is, for the moment, overwhelmed by its more obvious marvels. That it took but five years to build, yet cost the enormous sum of sixty-four million pounds sterling, is a record which stands alone in the religious building of the world, but it always seems to me more remarkable that the building should have survived the catastrophes in which the parts of the city that surround it have been continuously involved. It had hardly been built when it was subjected to a series of severe earthquakes which lasted, on and off, for twenty years; perhaps the most continuous and recurrent series of earth-tremors that the city has ever undergone. Exactly twenty years after its dedication the church suffered the only disaster that it ever sustained; the dome fell in and much of the fabric was damaged. The earthquakes had had their inevitable result.

But what is, I think, one of the most remarkable features of this building, is that it has never suffered any perceptible damage between this collapse of A.D. 557 and to-day. Fire after fire has raged below the great church; siege after siege has echoed round its walls, and conquerors have twice swarmed into its precincts and brought murder and massacre into its holiest parts; even as late as 1755 a devastating fire brought the lead dripping molten from its domes and roof, and from 1915 to 1918 aeroplanes dealt destruction within the city walls; yet the great bastion-like church stands to-day firmer even than when it was built, for the very catastrophe which brought its dome crashing to the ground in 557 was destined to strengthen its fabric and solidify its structure.



THE DOME OF SAINT SOPHIA.
This photograph, taken from the gallery, clearly shows the distorted arches.

On a recent visit I talked at length with the able Turkish architect to whom was entrusted the repair of the dome after the dilapidations caused by ten years of neglect during time of war. He knows the fabric of the building inch by inch, and with him I examined every crevice of its highest dome, within and without, and looked at every portion of the gallery that runs giddily round the dome and every slope and slant of the mighty leaden roof. In the course of this examination he pointed out to me the fact that there is hardly an archway that is symmetrical and hardly a line that is straight. At first I thought of the refinements of the Parthenon, and wondered if the Byzantines had such deep consideration for optical effect. But the distortions were too marked, the lines too broken. Every arch was warped, every wall sloped, but without seriously affecting the grand effect of the whole.

THE GROUND FLOOR.
The mosaics have been irreparably damaged by the passage of time and by the intrusion of moisture

My friend the architect offered what is, I think, the true explanation.

The church took the ridiculously short time of five years to build. Its building was a masterpiece in the organization of time and material. The swift genius of triumphant Christianity brooked no delay. But in the process of building, the bricks of the church were bonded with an inordinate quantity of mortar, as an economy either of time or of money. Then came the series of earth tremors which shook the building continuously and, as it were, settled it down. As the mortar became dry contraction followed, and with the contraction came an inward thrust on to the foundations. This thrust loosened the grip of the first dome, which was even more flat than the remarkably flat dome that we see to-day. The dome fell, but the very causes of its collapse worked in other ways to strengthen the rest of the fabric. The dessication of the mortar led to the contraction of the building and the contraction to solidification. The mortar, once dry and contracted, set like solid concrete. Arches went awry and walls slanted, but, in the process, they became like rock, regardless of their inclination or distortion. Only the dome was lost.

Fortunately, when the dome fell, some of the architects who had built the church were still available, and the technical knowledge of the first building was not forgotten. Isidore the younger, the nephew of Isidore of Miletus who was one of the two architects mainly responsible for the work of the first church, raised the dome by thirty feet so as to lessen the outwards thrust. We can only conjecture the appearance of the flatter dome of the first building, surely the most hazardous dome ever placed on a church! Isidore the younger was taking no risks. Many arches, which to him were superfluous, he filled with brick and rubble so as to give more solid support to what was superimposed. Recent wall clearance has revealed these obsolete arches and their filling. Here and there iron girders and clamps were inserted, though we cannot be quite sure that they belong to this early date.

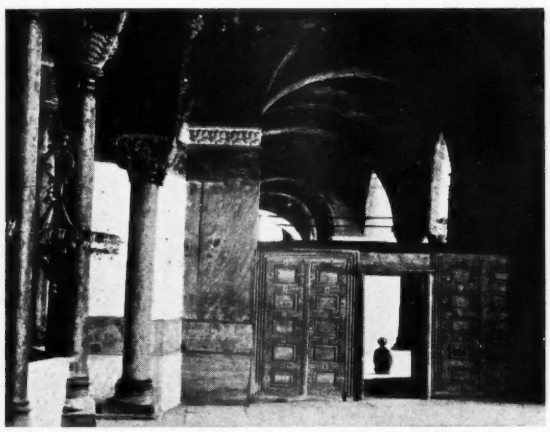
Once settled and solidified, the church was safe, for its foundations are laid on the living rock. Curiously enough, the rock is not very near the surface in the parts of the city immediately adjoining St. Sophia, for the church is built upon an outcrop. This has been established by sinkings just outside the buttresses and by an examination of buildings under the ground between St. Sophia and St. Eirene. Mighty cracks run vertically up the walls in various places. These

REPAIRING THE ROOF.
The buttresses of the dome have been remade in solid concrete and given a slightly outward batter.

were first observed in 1847 by Fossati, the Swiss architect employed by the Sultan Abdul Medjid to repair the whole building. But all the tests available and the closest examination has not revealed any extension of them. It is to be presumed that they are the cracks caused by the settlement of 557 and the subsidence of the whole fabric. I anticipate no danger to the building from collapse: it is rock-like in its strength and firmness. But the dome is always, and always will be, in danger from the invasion of moisture, that most deadly enemy of all buildings. To obviate this danger the recent repairs include a new binding ring of steel to that previously fixed round the dome by Fossati. In addition, the buttresses of the dome have been remade in solid concrete and given a slight outward batter so as to lend additional strength.

Both on the dome and on the rest of the roof the lead roofing has been completely renewed so that no moisture can now penetrate the building from above, and the danger to the mosaics of the dome, apparent in recent years, is thus avoided.

For the rest, the fabric seems to need neither renewal nor restrengthening, since none of the existing cracks have shown any tendency to increase and, as I have explained, the building is far more solid than was ever imagined. For future improvements there is much room, even on the assumption that the building always remains a mosque. By a simple process of ordinary cleaning, the marble revetments of the interior walls can be made to show their colour and their superb variety. The floor can be cleared of the carpet whose alignment towards Mecca so unhappily disturbs the normal orientation of the main building



A DOORWAY OF MARBLE.
Among the improvements which the author suggests should be carried out is the cleaning of the marble.

to the east and its internal arrangements. The great bronze door at the south entrance, the only original door surviving from the time of Justinian, with its austere decoration and its perfectly preserved monogram devices, could be cleaned with immense advantage.

Of the mosaics little can be said. It is hardly to be hoped that even under the enlightened regime of Republican Turkey they will be relieved of the white-wash that encumbers them, for St. Sophia is a storm centre of religious faction and political intrigue and a building far harder to touch than any mosque in Stamboul. From the close examination which I have made of the mosaics of the dome and of the upper galleries, I doubt if a complete cleaning will result in much except grave disappointment. The mosaics have been irreparably damaged by the passage of time and the intrusion of moisture in the period that has intervened between the conquest of 1453 and the repairs of Fossati. Much that looks like obscured mosaic design from a distance is in reality but painted plaster that hides a patch from which the mosaic has fallen. The best preserved and the most impressive mosaics are the four Cherubim whose heads are obscured by gilt wooden stars affixed by faithful Moslems who could not tolerate the representation of the human face. These can be made perfect and will remain, perhaps, as the finest mosaics of the church.

Another and most profitable alteration would result from the lifting of the Turkish flagstones of the floor of the gallery and of the main floor. Beneath will certainly be found the burials of Christian priests and dignitaries and of Crusading notables. In many of the smaller churches which were converted at the Conquest into mosques the Christian tombs were ruthlessly violated and robbed of their contents. That this was also the case in St. Sophia is less likely so that the probability of discoveries in tombs is considerable. The actual tomb, believed inviolate, of Henry Dandolo himself still lies visible, with his name in Gothic characters, in a corner of the upper gallery. What treasures these tombs might contain is incalculable. But nothing can dim, even in its present condition, the splendour of this oldest cathedral of Christianity. The amazing vastness of the space which is enclosed by walls unsupported by pillars, the soft dark colours and the exquisite variety of capital and tracery, make it a monument which has never been exceeded either in architectural daring or in perfection of detail.

DELICATE CRAFTSMANSHIP.
The Church of Saint Sophia is almost unique in the exquisite workmanship of its capitals and tracery.

# The Village Heroes of Kathiawar.

**By James Hornell, F.L.S., F.R.A.I.**

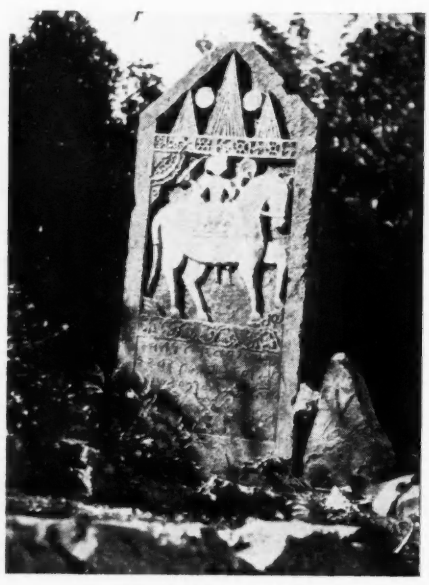
*Late Director of Fisheries to the Government of Madras.*

*An interesting link with mediaeval times is to be found in the Peninsula of Kathiawar, where Feudalism is still the form of government. Hero worship is an important national trait, and in every village, however poor, throughout the land there are elaborately carved monuments, erected to the memory of local warriors.*

KATHIAWAR, the great *presqu'île* midway between Bombay and Karachi on the north-west coast of India, is changing rapidly owing to the invasion of the railway and the building of modern commercial harbours at Port Okha and Beti Bandar, to say nothing of the advent of the schoolmaster and the political agitator. But it still remains a feudal land, a country parcelled out among some hundred and fifty chieftains, each claiming sovereign rights within his territory. Some have real power and importance, among them the enlightened Gaekwar of Baroda and the once popular cricket idol, Ranjit Sinhji, now the Maharaja Jam Saheb of Nawanagar. The latter is a progressive and enterprising ruler, whose capital of Jamnagar, remodelled and rebuilt with the assistance of Sir Edwin Lutyens and others, is probably the most attractive of modernized Indian capitals. Many of the other rajas, nawabs and princelings own but a ruined fortalice, perched on a hillock, the iron-spiked gates still shut and barred at sunset, and surrounded by clusters of mean houses, huddled under the walls for protection against raiders.

The land is an epitome of England and Scotland in mediaeval times; to travel through the country from village to village, mounted on one of the spirited little ponies for which Kathiawar is famous, escorted, perhaps, by a fierce-looking bearded ancient armed with dagger and scimitar; or to crawl at funereal pace, jolting and swaying over deeply rutted roads in a creaking bullock cart; such experiences give a far clearer insight into life in the middle ages than the study of all the books ever written on the subject. "What is that pall of smoke away to the north?" I once asked a village headman on the border of the Gir forest. "That," he replied, "is where a band of outlaws have their home. They have become too troublesome and bold of late, and so the Nawab has ordered them to be burned out."

These outlaws are gentlemen of the Robin Hood variety. They have their own code of honour. When they plan a raid on a village, notice is usually sent to the headman, informing him of the decision to descend upon his village and remove whatever they may consider of service to themselves. No hint is given of the date when the raid is to be carried out. It may be within a few days, or months may elapse before it occurs. And, like Robin Hood, these modern outlaws have a retributive way of despoiling most thoroughly whoever is an oppressor of his neighbours. A greedy moneylender suffers in particular. The raiders love to rifle his money bags and to destroy the records of debts owing to him. Because of this the outlaws are popular with the poorer villagers, and such sympathy is the greatest asset the outlaws have; it secures them early information of any move to be made against them; if captured, an ironclad alibi prevents justice being done.



A TYPICAL MEMORIAL.

The rank of the hero is shown conventionally by the trappings of the horse he rides: if they are richly caparisoned, the man was a chieftain, while inferior ranks bestride a plain saddle.

Their numbers are recruited to a considerable extent from the families of the smaller chieftains. In India, if a man possesses money or position, his poor relations consider it to be his bounden duty to provide for them. The thread-bare courts of the Kathiawar princelings are crowded with

these people. From time to time an impecunious chief, finding the drain at last unbearable, rises in wrath and drives the idlers out. Knowing no trade, for they are too proud of birth to learn one, how may poor gentlemen live unless they frequently join an outlaw band? Recruits of this type are welcome. Desperate, landless men, bitterly resenting the treatment received from the head of their clan, and with friends in his stronghold, their help and knowledge are invaluable should the outlaw captain ever decide to raid the chief's possessions.

A PIRATE'S CENOTAPH.

By far the most interesting of these quaint memorials bears the representation of a square-rigged, four-masted ship of the East Indiaman type. It commemorates the death of a pirate.

Many of the people of Kathiawar, in addition to those of the ruling caste, claim to be of Rajput origin or, at least, of Rajput affinity. Their customs are similar and bravery is still esteemed the highest virtue. Wherever villages contain a strong element of the Rajput type, memorial stones to heroes and heroines long since dead are usually to be met with. These are particularly numerous in the little territory of Okhamandal, belonging to Baroda, at the extreme north-western corner of the peninsula. Here is the home of the Vaghers, a once lawless and turbulent tribe. From time immemorial they have avoided honest work, represented here by strenuous agricultural labour in a land of deficient rainfall; rather they preferred a gentleman's life of piracy and pillage. Piracy was greatly circumscribed early in the nineteenth century owing to the vigilance of British ships of war, but predatory raids by land continued unabated till 1859. In this year their overlord, the Gaekwar of Baroda, found himself unable to enforce law and order in the territory and to afford protection to the orderly among his Okhamandal subjects, and appealed to the Government of India for assistance. A naval expedition, consisting of several vessels belonging to the then existing Indian Navy, with transports conveying a strong military force, was accordingly despatched from Bombay to reduce the truculent tribesmen to ways of peacefulness. On 6th October, 1859, a heavy bombardment was launched at the fortifications of Beyt, the second most important town in the territory, where the rebels had concentrated their forces, a landing party was disembarked with orders to storm the fort through the breach which the British guns had made.

The attempt to capture the town by escalade failed. The Vaghers fought fiercely, nobly upholding the Rajput tradition of bravery; they poured in a desolating fire upon the storming party and ladder carriers. To add to the difficulties of attack, the rebels had covered the face of the breach with masses of prickly pear and thor bushes, the most effective form of *chevaux-de-frise* possible to devise. The attack was abandoned as hopeless without further bombardment and the storming party retreated to the ships, having suffered severe loss, including that of two British officers. During the following night the defending force abandoned the town, retreating to Dwarka, which had in turn to be bombarded both by land and sea a few days later, before the rebel tribe would make submission.

In passing, it is interesting to note that these two actions are memorable, not only as being the last offensive operations within the confines of India of John Company's Indian Navy, prior to its abolition in 1863, but also as being the last bombardment by British ships of any Indian fortified place. After the pacification of Okhamandal, both sides erected memorials to their dead. The British monument consists of an unpretentious flat-topped tomb in the centre of a tiny walled-in enclosure on the desolate high ground south of the town of Beyt. Graven on the covering slab is a laconic inscription without dedication. The Vaghers were accustomed to erect more ornate memorials, for, like the Rajputs, ancestor cult and veneration of heroes are, or were till recently, living forces in their tribal life. These cenotaphs consist of upright slabs whereon the dead warrior is represented conventionally either on horseback or on foot. Outside the village of Gopi Rajpura, lying opposite Beyt Island on the mainland side of the narrow dividing strait, a group of these stones bears witness to the heroism of the defenders of Beyt in 1859. According to the village headman, the rank

of the hero is shown conventionally by the trappings of the horse he rides; if they are richly caparisoned after the fashion of the chargers of mediaeval knights, the cloth elaborately embroidered and fringed with tassels, he was a man of high rank, a chieftain; if he bestrides a plain saddle, he was a man of inferior status; represented without a horse, the hero was a stripling, as yet unmarried. No village, however poor or mean, is without at least one or two of these memorials; more frequently, there is a series of different ages and designs, indicating cycles of warfare or unrest.

By far the most interesting of these quaint Vagher memorials is one of a numerous group outside the walled town of Aramra, once of considerable importance as the last halting place of Hindu pilgrims on their way to the holy shrine of Krishna across the channel on Beyt Island. On this stone, instead of the conventional horseman, there is carved in strong relief, the representation of a square-rigged, four-masted ship. The vessel has the distinguishing characteristics of a large East Indiaman of the century period ending about 1720. The poop is notably high, the bows low, with a curved stem turned inwards at the head. Two rows of gun ports are clearly shown along the side, while a massive fixed bowsprit rises at a high angle clear of the stem. The foremost of the four masts is a short spritmast stepped upon the bowsprit and carrying a square sprit-topsail. Of the foremast, mainmast and mizzen, the mainmast is the tallest. All carry square sails, which, from their positions high up on the masts, obviously represent topsails; the larger lower sails have been omitted by the sculptor in order to provide space for the representation of three warrior figures of disproportionate dimensions, each brandishing a scimitar.

STONES WHICH ARE STILL VENERATED.

Many of the memorials stand neglected, but others still receive the homage of their descendants who periodically paint the figures with vermillion. This curious treatment accounts for the lack of detail in the stones shown above.

On my asking the significance of this sculptured ship, so unlike any type of Indian sea-craft, the headman summoned a villager of the boat-building caste, people who serve also as seamen on coasting vessels. "This man," he said, "is a descendant of the one to whom the memorial was erected." When the villager arrived, he stated that the hero commemorated was a pirate of great renown, the captain of a pirate ship manned by kinsmen of the Vagher tribe; he met his death during an attack upon a European ship. Whether the foreign ship was taken or the attack beaten off, he could not say. He maintained also that the ship represented was the one commanded by his ancestor, but this is manifestly impossible. No Indian pirate on the coast of Kathiawar would put to sea in any but a lateen-rigged ship, and most certainly not in such a large and powerfully armed vessel as is indicated by the sculptured representation, though to build a ship of this type was well within the capacity of Indian shipwrights in the Bombay shipyards. It is much more likely that the intention was to depict the vessel which the Vagher freebooter attacked and probably captured. Cogent reasons in favour of the supposition that the attack was successful are the fidelity of the details — the sculptor must have had ample opportunity to study those of such a ship at close quarters—and the fact that the three men on the deck are brandishing their weapons with every appearance of acclaiming a glorious victory.

The pirate's descendant stated that his ancestor was the fifth life from and including himself. Taking twenty-five years as the average for each of the four generations, together with an extra twenty-five, as my informant was over fifty years of age, we arrive at an estimate of about a hundred and twenty-five years as the period since the pirate's death. This would appear to fix his exploit at some time during the opening years of the nineteenth century. Such a dating is manifestly erroneous; the worn condition of the stone, the ruinous state of the platform on which it stands, and, most decisive reason of all, the antique type of vessel represented, all controvert this conclusion. Family traditions of the kind under question are notoriously unreliable in India; the five lives spoken of are probably a guess, and we must

rely solely upon the evidence afforded by the design of ship shown upon the memorial stone. This has all the outstanding characteristics of vessels built during the hundred years subsequent to 1620, more particularly noticeable in the form and position of the sprit topmast. The sculpture shows this to be stepped at the extreme end of the bowsprit; a jackstaff bearing a flag is also present and it is notably short. Both these features are characteristic of ships of this description—war-ships and armed merchantmen—rigged between 1620 and 1720. The absence of a jibboom further certifies this dating, for this spar was not authorized for the Royal Navy till 1705. The high poop and quarter-deck and the incurved beakhead are also features found in vessels of this period. A transverse bulkhead at the butt end of the bowsprit is another characteristic common to ships of the time named—its presence is clearly indicated in the sculptured figure abaft the incurved beakhead.

HERO STONES AT BEYT.

No village, however poor and mean, is without at least one or two memorials to dead warriors, every place favouring its own distinctive design. More frequently there is a series of different ages and designs, indicating cycles of warfare.

The extreme accuracy of the details is amazing. It attests both the skill of the sculptor and the greatness of his powers of observation; there is nothing crudely conventional in his treatment of the theme—even the shrouds are represented in addition to the major features enumerated. Flags fly from all the mastheads and an ensign is carried at the stern. Such accuracy is incredible unless the sculptor had had ample opportunity to study the details at leisure; and this would be impossible unless the ship had been captured and brought into Beyt harbour by the victorious Vagher pirates. If so, this stone bears silent witness to a fiercely contested sea-fight as well as being a hero's memorial; the death of the pirate chief and probably of two of his lieutenants—for three figures are shown standing on the deck—would be cruelly revenged, and must have entailed a tragic death for those Europeans who were so unfortunate as to survive the capture of the ship. It is a pity that we do not know the full story of this great sea-fight.

Life must have been cheaply held in the old days to judge from the number of hero stones still standing in every town and village. Each place favours its own distinctive design in the details of the sculpture. In some, the warrior carries a lance, in others a sword is brandished in one hand, while, in some cases, a round target is held aloft. Some hold both sword and spear. Whatever other devices may ornament the upper part of the many local memorial stones, conventionally crude figures of the sun and moon are always present, symbolizing the pious hope of the family that the memorial may last as long as sun and moon endure.

Men do not monopolize all the glory of heroic death. The magnificent but sombre legend of the sack of the Rajput fortress of Chitor is still told in Kathiawar with proud enthusiasm; of how before the sortie of the surviving warriors, which marked the closing scenes of the defeat, their women committed *suttee*, throwing themselves upon the flames rather than become the playthings of the conquerors. The memorials to their memory remain to-day. The road which leads to the ruined city is flanked with stones on which the conventional symbol of suttee is sculptured; the flexed arm severed at the shoulder.

To people nourished on such stories, emulation comes naturally, and everywhere in Kathiawar, even outside the most poverty-stricken hamlets, examples of memorial stones have been erected to the memory of devoted wives who committed suttee.

Many of these humble memorial stones to village heroes and heroines stand neglected, but others still receive the homage of their descendants, who periodically visit these memorials to feed the hungry ghosts and to paint the figures with vermillion, the latter an act of veneration similar to that accorded to a deity. This treatment accounts for the lack of detail noticeable in the four stones found at Aramra. But times are changing rapidly, and, with the advent of the cinema, the youths of to-day are better acquainted with the antics of the film comedians than with the deeds of the heroes of their own land.

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# The Next Step in Ornithology.

By E. M. Nicholson.

*In* DISCOVERY *for April, Mr. Nicholson stressed the need for organized measures in bird-marking on an international scale, and he now describes a scheme for simultaneous observation around the North Sea which is being put to the test this autumn. Although the project is faced with almost insuperable difficulties, it definitely marks an important step forward in the science of ornithology.*

IN common with other sciences, ornithology has passed the stage when it can be carried on profitably upon the basis of a number of more or less isolated enthusiasts, working in what leisure they may be able to devote to it. The intense specialization of the present time has finally exterminated the picturesque Victorian figure of the ornithologist who could still claim to have everything that was known of the subject at his finger-tips. We have already students of migration, of geographical distribution, of flight-mechanics, of plumage and structure, of territory and economics, of courtship, of population, of ecology, and of other equally well-marked branches of research whose methods, vocabulary and results are known to one another or to the general body only to the most vague and unsatisfactory degree.

### An Anti-Scientific Tradition.

This complexity, unfortunately, is not the only handicap: the whole tradition of ornithology is strongly anti-scientific. Its very popularity has swamped it for the past four generations with birds'-nesting schoolboys who have only partially succeeded in growing up. Birds have remained for the vast majority a hobby rather than a serious field of work, and this applies not only to egg-collectors, shooters and sportsmen of the old school, but almost equally to the bird-photographers and even the bird-watchers of the new. Camera and field-glass are doubtless more humane weapons than gun and egg-drill, but they do not necessarily involve that essential change of attitude without which ornithology must continue to be an amateur and haphazard pursuit leading nowhere in particular. The passion for chasing rare birds has not been diminished by a growing sentiment against killing them when found; the ambition for adding something to the county list is still dominant. Ornithological publications are perpetually inundated by a flood of scrappy records of supposedly uncommon occurrences, submitted on the assumption that someone some time will reduce them to order in a painstaking compilation; an assumption which is rarely justified, since the ordinary worker is happy enough to collect odd bits of raw material, but very reluctant to undertake any systematic task.

No doubt there is more useful scientific work on birds being done now than at any earlier period, but the ornithological machine, like the steam engine, must be judged not by its absolute performance but by the efficiency it attains, and this efficiency is lamentably low. In other words, most of the people concerned are wasting all their time, and practically all of them are wasting a good deal of their time. The problem of reducing this inefficiency, of making ornithology more scientifically fruitful, deserves precedence over all the special problems with which the minority of serious students is confronted.

This central problem resolves itself into a question of organization, for the mass of observers capable of useful work who are not at present engaged on any can only be harnessed to a definite scheme. Any stimulus to individual effort, however well responded to, could only lead to an appalling waste of energy, offset by a small fraction of valuable achievement.

### Organizing Bird Watchers.

In advocating the replacement of the detached observer, working on his own by an organized group who collaborate in a definite plan, it is unnecessary to deceive oneself into believing that the process is an unmixed gain. If the individualist were capable of choosing his own line intelligently, mastering the problems outstanding and publishing his results in a manner which would make them generally available, no doubt he would have the advantage of any ordinary combination. But the trouble in practice is that the individualist refuses to be individual. He devotes himself to keeping records of a character which has ceased to be useful since the period of Gilbert White: in order to put an appreciable number of observers on novel and fruitful research, it is necessary to give them guidance. If the bird-watchers of any country were organized on even a narrowly conceived plan, the effect would immediately be, not to stereotype their activities, but to diversify them, so marked is the rut into which the great majority has fallen.

The objections to organization, therefore, are theoretical rather than real. That the ordinary observer is a creature of habit rather than enterprise is inevitable from the circumstances of his life; he has neither scientific training nor the opportunities to keep abreast of his subject, and no one is more ready to recognize how much he might benefit from expert direction within suitable limits. The strength of the demand to be given something useful to do is evidence that the tendency towards a more definite organization of ornithological work is not confined to the scientist, who appeals for more eyes and ears to secure the data which he urgently needs, but is shared by the keen yet untrained lay observer aware of the repetitive and unfruitful nature of his ordinary occupations.

### Co-operation Already Tested.

The implications of organization are sufficiently clear. The tendency puts the responsibility for field research principally into the hands of the small minority of trained whole-time experts, and on the imagination, resolution and energy of those experts most of the work of the near future must depend. In bird-marking the process has already reached maturity, and in this special case the machine with the man in control of it subordinates the field collaborator to an extent unlikely to be repeated when census and other joint enterprises reach a similar development. The success of bird-marking proves the spirit of co-operation waiting to be harnessed by leaders commanding the confidence of numbers of observers. Temporarily, and for limited objects, this co-operation has already been tested. The "British Birds" Census of Heronries in 1928 involved the help of about five hundred persons in all parts of the British Isles, and this was a hasty effort with no previous experience and no pre-existing organization to depend upon. No doubt the experiment cuts both ways, and a proportion of those who willingly give valuable help to an isolated inquiry might fail to support more extensive efforts from want of either time or inclination. To develop all possible sources of information without trespassing excessively on the goodwill of those not primarily interested is, in fact, already a serious question for the various biological investigations now in progress. On the other hand, steady application to the solution of various problems in the field readily collects a keen and consistent group of observers who are prepared to help to any reasonable limit, and as the technique is acquired the quantity of correspondence necessary to elucidate difficulties and check mistakes tends gradually to diminish. An obvious parallel is the net of voluntary meteorological stations operated in all parts of the country, and the related phenological reports organized through the Royal Meteorological Society actually link up with the biological problems.

While co-operation on a national scale is still in the experimental stage, with no permanent machinery, a scheme for international combined investigation appears remarkably ambitious. But Dr. Drost, chief of the Ornithological Observatory on Heligoland, has obtained a response which he considers very satisfactory for his plan of simultaneous international observation around the North Sea, and the putting to the test of this project in the present autumn marks an important step forward. The conception of a cordon of observers stretching through Norway, Denmark, Germany, Holland and Belgium to the Channel Coast of France, and back by the North Foreland, Orfordness, Blakeney, Scolt Head, Spurn and the Farnes up to the Orkneys and Shetlands, looks so grandiose that it is surprising to learn that its realization has proved practicable. The intention is to appoint special days between mid-September and mid-October on which certain observations, rendered uniform by the use of a standard schedule, shall be made at as many as possible of the suitable stations round the North Sea. No doubt some of those who volunteered months ago will be prevented from occupying their posts, and the difficulty of ensuring that a number of persons in half-a-dozen different countries, mostly speaking different languages from headquarters, shall all function at the right time without leaving any serious gaps is in itself enough to deter all but the most resolute of organizers.

### Serious Obstacles.

In the Census of Heronries, which lasted several months, there were serious obstacles in arranging for various areas to be adequately covered, while in others there was ample response for duplicate or triplicate returns.

A census of all transient and resting species and individual birds, on one day at fixed hours, is by no means as simple as it sounds. Most of the birds met with at any point on the North Sea shore at this season might equally well be transient or local native stock so far as their species goes, and it is not clear how anyone can feel satisfied to distinguish between the two unless he has done some continuous observation of an intensive sort at the same point, in order to get to know which are the resident or native birds, before he proceeds to sort out the transients. An indefatigable observer has sent me from time to time the results of

protracted census work on a patch of land near the Sussex coast : although he has secured exact counts several times a month under all sorts of conditions for more than three seasons, one must still hesitate to say what the resident stock is from which transients would have to be deducted. In November, 1927, for example, the green woodpecker occurs in only one count out of ten, and the little owl in two, but it is unlikely that either of these are in any ordinary sense migrants ; they are probably birds with an extended foraging range. Stonechats, up to four individuals, occur on seven occasions, but in February, 1928, none appear till the 25th, and in March only two odd birds occur in eight counts. In September-October, 1928, they are represented in all ten counts by between two and thirteen individuals. In January-February, 1929, there are none in ten counts. In March, there are again two odd birds. In September none are found, but in October, there are always between one and two.

### Defining Transients.

Here in these observations by Mr. J. F. Thomas is contained probably the only full and accurate material in this country on which a definition of transients could be based, and the more it is considered the more arbitrary any definition seems to be. The idea that on any given area there will be found a certain number of birds which belong there and are always present, and a residue which do not belong—the transients—is, unfortunately, not confirmed by statistical work. In fact, it can only be by chance that any two counts of the same area give identical results. Looking at the subject from a very broad standpoint, it may be possible to distinguish the bird population of a country or a region from the migrants intruding into it, but on a closer scrutiny there is no such distinction : the bird population of any ordinary area is constantly changing not merely through migration but through readjustments of territory, seasonal supplies of food, death and colonization, and the countless short-distance wanderings of local birds. On the other hand, when Dr. Drost's scheme aims as an alternative at recording migration in progress, with directions of flight and so forth, it meets the well-known difficulty that migrants will often diverge from their course to approach a ship, lighthouse or piece of land, and so upset any deductions. Since they naturally see such conspicuous objects before they can be seen from them, the exhortation to record data about changes of direction and steering towards islands, capes, and other landmarks appears decidedly optimistic.

The scheme of an international net of observers round the North Sea is attractively ambitious but dubiously feasible ; it seems improbable that many of the data will definitely link up as they are intended to, and the margins of error in the observers and their subject must be so serious that if they are adequately discounted the residue of proved unambiguous facts must be remarkably small in proportion to the effort involved. In this respect the plan contrasts with a ringing campaign or a census where, provided the observers and the scheme adopted are not seriously inadequate, results are definitely assured in proportion to the response, and the risk of weather conditions or absence of movement at the prearranged moment, or complicating factors of other kinds, upsetting the scheme is practically ruled out. The great attraction of the North Sea net is the hope of being able to draw migration sketch-maps comparable to the weather sketch-maps now published daily for the northern hemisphere. The comparison emphasizes the shortcomings of the scheme, since meteorological data are readily taken by routine on similar instruments under strictly comparable conditions, and are of essential importance to large numbers of authorities on sea and land, whereas bird movements interest only a minority working in limited leisure, cannot be continuously studied on a large scale, give far more negative results, and are extremely susceptible to purely human variations and errors in recording them.

### A Convenient Unit.

While the value to science of the North Sea project remains to be shown, its value in advancing organization for field work ought to be considerable. It has the merit of emphasizing the fact that, for ornithological purposes, the North Sea basin makes a convenient unit, with the same general avifauna and, in all the countries concerned, a considerable and growing number of available observers. In all these countries it would already be feasible, for example, to take an international simultaneous census of heronries on the model used here in 1928, and in all except, I believe, Norway, a more or less satisfactory survey of the heronries has already been independently carried out. For migration, an international effort to develop ringing and trapping stations would probably prove more fruitful than observational methods ; concentration on such species as the fieldfare, redwing, brambling, hooded crow, starling, skylark, and other characteristic North Sea migrants would undoubtedly solve many outstanding problems. Co-operative studies of the fertility of widespread species in the same season over a large part of its

(*Continued on page* 338.)

# The Greenland Ice-cap Expeditions.

**By F. Debenham, M.A.**

*Director of the Polar Research Institution, Cambridge University.*

*The British Arctic Air Route Expedition is unique, not only for the youth of its members, but also because it is the first British expedition to spend a winter in the Arctic for over thirty years. The value of the meteorological results will be considerably increased by the fact that a German expedition with similar aims is in the field at the same time, and such co-operation as is possible has been arranged.*

LAST year our attention was directed towards the Antarctic, following the expeditions of Rear-Admiral Byrd, Sir Douglas Mawson, Sir Hubert Wilkins and the Norwegians. This year the Arctic is all too vividly in our minds on account of the discovery of the tragic relics of the Andrée expedition, and hardly less so because an attack is being made upon the problems of Greenland by at least two major expeditions. These expeditions have set out to find out more about the Greenland Ice-Cap, that vast sheet of ice which covers over ninety per cent of the island to an unknown depth.

## The Main Problems.

The questions which scientists ask themselves about this ice-cap are not abstruse, in fact they differ little from those which a child would put quite naturally: how thick is the ice-sheet, how did it get there and can one walk on it, live on it, and land on it in an aeroplane? These are the main questions to be answered by explorers, though naturally they assume a somewhat more complicated form. Thus, before one can say whether an aeroplane may make use of the plateau, one must know many other things besides the average condition of the actual snow surface, such as the temperatures to be endured, the force and direction of prevalent winds, the visibility, and so on. Moreover, since the ice-cap itself is comparatively inaccessible, any future air ports would be on the fringe of ice-free country not covered by the ice-cap, and this requires examination and surveying. Both the German and the British expeditions, therefore, are doing work which is in the nature of reconnaissance, with the possibilities for air routes over Greenland as the chief object.

It is over thirty years since a well-equipped expedition from England spent a winter in the Arctic, and for that reason as well as for certain other rather unique characteristics the British Arctic Air Route expedition will claim our attention first. It is somewhat unusual, for instance, to hear of a large expedition being led by a young man in his early twenties, who, moreover, has already led two small expeditions, one to Spitsbergen and one to Labrador. That his companions, fourteen in number, should also be youthful is perhaps a corollary of the first statement, but their average age is one to surprise the polar explorer of the past. It has even given rise to the usual aphorisms on youth and inexperience, but these aphorisms and doubts do not come from those who have actually met Watkins and his companions and have observed the spirit which permeates that expedition.

As is generally the case with British expeditions, a shortage of funds has somewhat limited their scope, and more purely scientific investigations have had to be sacrificed to some extent to the main purpose of the expedition, a reconnaissance for an air route over the southern third of the Greenland plateau.

## Early Plans.

Transported with considerable cramping and discomfort by Shackleton's old ship, the *Quest*, the expedition has now erected its main base on the mainland behind Angmasalik, the nearest inhabited part of Greenland to Iceland. One party has made a good journey on to the ice-cap, over a hundred miles from the coast, and has left there a subsidiary base with two men for meteorological work. The ship has gone northwards to assist in a rapid survey of the coast and immediate hinterland, assisted by aeroplane photographs. By the time this article is in print the *Quest* will be back in Europe and the expedition will be back at headquarters. Judging from the spirit of the leader, however, there will be very little sitting still at the base, and his plans include long journeys over land and ice-cap by means of dog sledges, always with surveying and meteorological observations as the main objective. The expedition includes at least four capable surveyors, two professional air pilots and one or two amateurs, several who are capable of making the routine meteorological observations which are required, a qualified geologist,

a wireless expert and a doctor. Although Greenland has been crossed in four places, the journeys have been made in haste and we still know comparatively little about the surface of the ice-cap. It is Watkins' intention to try and make a longitudinal traverse of part of it which will determine its general contour in that direction.

### The German Expedition's Aims.

The German expedition, while having the same general aims, is quite different in other respects. It is very much larger than the British expedition and, though it has no aeroplanes, its transport methods are much more complete, including two motor sledges, twenty-five Iceland ponies, and a hundred dogs. It is commanded by a scientist of note, Professor Alfred Wegener, famous for his theory of Continental drift and an explorer of considerable experience in Greenland, which he crossed with Dr. Koch as long ago as 1913. He has with him a staff of twenty scientists, some of whom are, like their leader, of international repute.

Their plans are correspondingly more comprehensive than those of the British expedition and include gravity surveys, determination of the thickness of the ice-sheet by seismological apparatus, and a very complete programme of meteorological observation. No less than three stations for the winter are planned, one at each end of a route across almost the broadest part of Greenland and one at the summit of the ice-cap. Such an ambitious programme demands very careful organization and very sound transport, but there seems no reason to doubt that these are available, and the results to be obtained should inaugurate a new era in the scientific exploration of the polar ice-caps. Commencing operations from the western side of Greenland instead of the eastern, the Germans were in the field early this summer and propose to continue for another full year.

It will be seen, therefore, that the two expeditions are curiously complementary while showing marked contrasts, and the value of the meteorological results in particular is greatly increased by the fact that they are in the field at the same time. Moreover, such co-operation as is possible between the two has been happily arranged. The spectacle of an expedition of young Englishmen without great experience co-operating with one of considerably older Germans on the same general problem of the nature of the Greenland Ice-Cap and its weather, and the feasibility of using Greenland for air routes between the Old and the New World, is one which certainly appeals to the polar explorer, who has always been ready to be international in spirit. It will, indeed, interest everyone to follow the fortunes of these two ventures.

And how far will our primary questions be answered as a result? Professor Wegener with his seismological and gravity apparatus will tell us the thickness of the ice-sheet. Watkins and his energetic companions will tell us something of its profile in a north and south direction of which at present we know nothing. Their combined results will assuredly tell us much more than we knew before about life on the ice-cap itself, for so far only a small party belonging to Professor Hobbs' expedition from Michigan has spent a winter on the plateau, and they were not in a truly representative part of it. Their meteorological records should enable them to discover the possibilities for flying at various seasons, and Watkins' surveys in particular should point the way to possible air ports of the future.

### Origin of the Snow.

Perhaps the most baffling question of all is the origin of the snow which forms the ice-cap. Various theories about continental ice-caps and permanent anticyclones have attained prominence of recent years, and the final proof of any one of them rests with the meteorologists and depends very much upon the sort of measurements which will be made at the British and German bases on the ice-cap during next year. Two important elements in the problem are the rate of wastage by evaporation (ablation) of the snow on the surface, and the rate of movement of the ice mass towards its edge. Measurements of the rate of glacier movement on the west coast have already been made by Nordenskiold and others, including Wegener himself, and it is hoped that Watkins will be able to do the same for the east coast ice. A host of minor problems will be met with, not the least important being those of a personal nature. No one has yet attempted to live at high altitudes on a continental ice-cap, motor tractors have not been tried under such conditions, and last but not least the flights by Watkins' pilots over the ice-cap in small machines will be different from anything that has been done in the northern hemisphere yet.

It will be remembered that there is to be an international assault on the meteorology of the Arctic regions in 1932, and this pioneer work on the ice-cap should be invaluable in planning that campaign as far as Greenland is concerned. When youth and experience both take a hand in a great problem, the world has a right to expect great things, and readers of *Discovery* will have watched with interest how fortune has treated these two expeditions.

# British Universities To-day : (8) Dublin.

**By Gilbert Waterhouse, Litt.D.**

*Secretary to the University Council and Member of the Board of Trinity College.*

*Founded by Queen Elizabeth as a residential university in the tradition of Oxford and Cambridge, Trinity College, Dublin, has been the centre of intellectual life in Ireland for nearly three hundred and fifty years.*

At least three ineffective attempts were made in the fourteenth and fifteenth centuries to establish a university in Dublin. Then, in 1585, an old project of associating a university with St. Patrick's Cathedral was revived, but had to be abandoned owing to the opposition of Archbishop Loftus. No further definite step was taken until 1590, when a group of influential citizens, headed by Henry Ussher, Archdeacon of Dublin, Luke Challoner, and two Scots, James Fullerton and James Hamilton, masters at the Grammar School, addressed a petition to the City Council, which had long been well disposed to the establishment of a university. The Council undertook to make representations to the Lord Deputy, Fitzwilliam, and more particularly to facilitate the scheme by providing a suitable site. The Archbishop and the Lord Chief Justice added their recommendations to those of the Lord Deputy, the royal sanction was immediately accorded, and by Letters Patent of 3rd March, 1591 (commonly called "The Foundation Charter") Queen Elizabeth founded the "Collegium sanctae et individuae Trinitatis juxta Dublin" to be "the mother of a university."

### Early Developments.

William Cecil, Lord Burghley, was appointed Chancellor, and Archbishop Loftus, Provost. A small endowment was granted but the funds for the erection and equipment of the necessary buildings were raised mainly by public subscription in Ireland. The foundation stone was laid by the Mayor of Dublin, Thomas Smyth, on 13th March, 1592, and the College was opened to students in 1593. The original number of students is unfortunately unknown, but it rose from 65 in 1613 to 472 in 1704, 933 in 1792, and to 1,300 in 1886. In 1913, the number was 1,285, of whom 211 were women. During the War, the response to the call to arms—a response which was entirely voluntary—caused the number of men students to drop to 535. There was a temporary return to the pre-War total in 1919 and 1920, when several hundred ex-service students resumed their studies, but the revolutionary period and the progressive impoverishment of the country caused a further decline to 936 in 1924. With the return to more settled conditions, numbers have steadily risen to 1,309 in 1929-30. The midsummer entrance for 1929 (158) was higher than in any year, with one exception, since the famine of 1847.

The original endowment of Elizabeth was generously supplemented by James I, and in 1637 Charles I granted a new Charter, which forms the basis of the present Consolidated Statutes of Trinity College and the University of Dublin. The Foundation Charter of Queen Elizabeth appears to have contemplated a possible multiplication of colleges on the lines of Oxford and Cambridge. However that may be, all attempts to develop in that way have failed, and for practical purposes "Dublin University" and "Trinity College" are synonymous terms. The framework of a university was undoubtedly created in 1591 by the appointment of a chancellor, by provision for the appointment of a vice-chancellor and proctors, and by the regulations for the conferring of degrees, but the primary executive authority was vested in the Provost, as head of the College. The power of appointment to the provostship originally rested with the fellows but passed to the Crown under the Charter of 1637. The chancellor is appointed for life by the senate. The vice-chancellor is appointed by the chancellor and presides, in the absence of the chancellor, at commencements or other meetings of the senate. This body consists of all doctors and masters who keep their names on the books of Trinity College. It is a body corporate distinct from the College, and is the final authority in all matters relating to the institution and conferring of degrees. The caput of the senate consists of the chancellor (vice-chancellor or pro-vice-chancellor), the provost, and the senior master non-regent, who is elected annually by the senate. Any member of the caput may veto any proposed grace for a degree.

The regulation of courses and examinations precedent to degrees (except in Divinity) and the nomination of the University professors for appointment (with

certain exceptions created by Act of Parliament or by the directions of private founders) are the concern of the University Council, a small body composed mainly of members of the teaching staff, together with representatives of the senate and of the Board of Trinity College. All matters relating to the Divinity School are dealt with by the Divinity School Council, on which the bishops of the Church of Ireland are represented. The provost presides over both the University Council and the Divinity School Council. All the acts of these bodies require the sanction of the Board of Trinity College, which is the supreme authority in all matters of administration, discipline, and finance. It consists of the provost, the seven senior fellows, two representatives of the junior fellows, and two representatives of the University professors.

The domestic cares of a residential university are innumerable. Rooms in College are naturally in great demand, but only about three hundred undergraduates can be accommodated. The remainder live in registered lodgings or with their parents, if their homes are in Dublin or its neighbourhood. A hostel for women, Trinity Hall, was opened in 1908 and now, after extension, accommodates about sixty students. About three hundred undergraduates dine in Hall daily, luncheon is served at a special buffet during term, and the Dublin University Co-operative Society caters for all ordinary requirements. Indeed, life in Trinity offers many attractions not easily found elsewhere. The spacious grounds form an oasis of some thirty acres in the heart of the city, provide the College clubs with ample facilities for cricket, football, hockey, and tennis, and still leave room for quiet walks, for flowers and shrubs and stately trees.

### A Varied Curriculum.

In Trinity Week, about the middle of June, the College races provide one of the principal athletic and social functions in Ireland. Similarly, there is ample scope for intellectual and oratorical activity in the College Historical Society, founded in 1770, the University Philosophical Society (1853), the Theological Society (1830), the Choral Society (1837), the Classical Society, and others of more recent foundation. There are advantages also in easy access to the theatres, galleries, libraries, and other institutions of a capital city, while the study and practice of law and medicine in particular are simplified by proximity to the King's Inns and the great Dublin hospitals.

With the passing of the centuries, the curriculum of the University has undergone the same changes as in other ancient seats of learning. Sweeping reforms were made during the provostship of Bartholomew Lloyd (1831-37), who opened a new and progressive stage in the history of the College. The School of Engineering, the first in any university in the United Kingdom, was opened in 1842, and degrees in engineering were created in 1872. In 1855, when open competition for the Indian Civil Service was introduced, prompt steps were taken to provide the necessary instruction in oriental languages, with the result that hundreds of Dublin graduates have found, and continue to find, their careers in the Imperial services. This widening of academic studies has proceeded so far that students can now obtain degrees not merely in Divinity, Law, Medicine, Philosophy, Classics, and Mathematics, but also in Modern Literature (professorships of French, German, Italian and Spanish were founded in 1778), Oriental Languages, Celtic Languages, Music, History and Political Science, Engineering, Natural Science, Experimental Science, and Commerce.

### Financial Needs.

Like other academic bodies throughout the world, the Board of Trinity College is constantly engaged on the task of apportioning its limited resources to ever-increasing demands for staff, buildings, and equipment. The needs of the University, like those of Oxford and Cambridge, were the subject of an inquiry by Royal Commission in 1920, under the chairmanship of the late Sir Archibald Geikie. The financial recommendations of that Commission were, in part, incorporated in the abortive Government of Ireland Act of 1920, which appeared to guarantee to the University of Dublin an annual subsidy of £30,000. This cheering prospect proved to be only a mirage, and the guarantee disappeared with the Act. The effects of this disappointment were acutely felt for some years, but there are now signs that relief may come from another source. In 1927 an influential Committee of graduates, reverting to the old maxim that self-help is the best help, established the Trinity College (Dublin) Educational Endowment Fund as a thank-offering to the College for the education received within its walls. It is hoped that this fund, which takes the form of a perpetual trust, will in the course of time assist the University to maintain that academic independence which is the first condition of a healthy existence. The University of Dublin, subsisting entirely on its endowments and on its fees, thus remains one of the few free universities of Europe, acknowledging no obligation save to the cause of learning and offering equal liberty to all who seek its instruction with good will.

Trinity College owes much, nevertheless, to the

THE QUADRANGLE, TRINITY COLLEGE, DUBLIN.

AN INTERIOR VIEW OF THE LIBRARY.

generosity of governments in the past. The Library, the oldest and largest of the existing buildings, was erected in the years 1712 to 1724 at a total cost of £17,000, of which £15,000 was provided by Parliament. The collection of books had its origin in a subscription of £1,800 from Her Majesty's army in commemoration of their victory over the Spaniards at Kinsale in 1601. The private collection of Archbishop Ussher, consisting of ten thousand volumes, with many valuable manuscripts, including the priceless "Book of Kells," was also a gift from the officers and men of the English army in Ireland. Among the more important additions to the Library since 1660 are the collections of Archbishop Palliser, Bishop Stearne, Dr. Claudius Gilbert, and Baron Hendrik Fagel. In common with the British Museum, the university libraries of Oxford, Cambridge, and Wales (Aberystwyth), and the Advocates' Library of Edinburgh, Trinity College enjoys the privilege of receiving a free copy of every book published in the United Kingdom.

The cost of the magnificent West Front of the College (1759), and the adjacent Parliament Square, was largely defrayed by a grant of £40,000 from the Irish Parliament. The two wings of the square are terminated with symmetry and dignity by the Public Theatre or Examination Hall (1787) and the Chapel (1798). Indeed, few universities can offer such a variety of architectural interest as Trinity College, but space permits only a brief reference to the unique Museum Building (1857), the Graduates' Memorial Building, erected by subscription to commemorate the Tercentenary (1893), and the Physical and Botanical Laboratories erected and equipped by the munificence of the late Chancellor, the first Earl of Iveagh.

### An Undeserved Reproach.

At some time in the beginning of the nineteenth century, Trinity appears to have been reproached as "the silent sister," as one that contributed nothing to the intellectual life of the country, a charge which drew from Dr. Mahaffy the witty comment: "Among all Irish institutions, probably the only one ever accused of silence is the University of Dublin." It is at least open to doubt whether Oxford and Cambridge were in much better case during a period of war, rebellion, reaction, and unrest not unlike the times through which Europe has recently passed. At any rate, the record of Trinity College, as shown by the catalogue of its great men, will bear comparison with that of any other university, British or foreign. Among poets and men of letters it claims Swift, Congreve, Farquhar, Goldsmith, and Moore; among scholars Ussher, Ware, Dodwell, Malone, Hincks, Whitley Stokes, Lecky, Mahaffy, Tyrrell, Dowden, and Bury; among philosophers Berkeley; among mathematicians Hamilton and McCullagh; among scientists Molyneux, Lloyd, and Fitzgerald; among theologians Magee and Salmon; among physicians Stokes and Graves; among statesmen and orators Burke, Grattan, Flood, Plunket, Curran, and a host of others. The past is full of splendour only, its troubles and dangers are forgotten. And what of the future? How will Trinity College face the changing times? The answer must be: exactly as it faced the changes of the past, that is, by the steadfast discharge of a university's supreme function—by single-minded devotion to the advancement of knowledge.

## The Next Step in Ornithology.

(*Concluded from page* 332.)

range offer an ideal subject for international work. But all such projects are hopeless without whole-time research workers to keep them going and to publish the results in a form which will make them generally available. The time when such operations may be left to chance and the goodwill of a few overworked men doing what they can in their spare time is past. Ornithology urgently needs a general staff to direct and make effective its efforts. The ambition is not a visionary one, and there are definite prospects that it may soon be realized. By the time this appears in print a scheme of ornithological research with a strong economic bias will already be in working order in this country, with sufficient grants to guarantee its continuance for a minimum period of three years. Only difficulties of raising funds stand in the way of organizing field work on a satisfactory scale without further delay.

To sum up, the long leisurely collecting and arranging stage in ornithology has continued for the past two centuries on the narrow lines laid down by pioneers, and has in many respects served its purpose so that it can do nothing further of importance without merely repeating itself. In order to remedy this shortcoming it is necessary for the specialists to take active steps in directing the energies of all bird-watchers to the most fruitful problems, and the growing complexity of these problems demands some closer relationship than that of a group of isolated workers in the same field. Both the specialists and the ordinary spare-time bird-watchers show every sign of being prepared for such a development and capable of making a scientific success of it.

# The British Association Meeting.

**By Major A. G. Church.**

*The addresses delivered at the Bristol meetings of the British Association were as illuminating and as varied in character as in previous years. A selection of the papers is summarized by our special correspondent.*

THE Bristol meeting of the British Association, which has just concluded, has further demonstrated the fact that those responsible for its organization realize that one of the main functions of the Association, if not the principal one, is to encourage in the people of this country a wider appreciation of the part played by science in national and imperial affairs; and this task is not easy. Success in any one of the thirteen fields of scientific enquiry, into which the Association has found it necessary to divide its labours, demands a high degree of specialization. It is inevitable that some of the specialist members of the Association regard its annual meeting as a summer session of the particular learned societies to which they belong. Their enthusiasm for their own subjects inclines them to forget that the Association was founded to bring the various specialized branches of science into closer contact, to enable them as specialists to present the results of their studies in a form intelligible to those working in other fields of inquiry, and to provide them with abundant opportunities for intellectual excursions.

### The President's Appeal.

This year the task of presenting a synoptic view of science based upon a lifework of study in a highly specialized field fell to Professor F. O. Bower, the first botanist for many years to occupy the Presidential chair. This he did in an address on "Size and Form in Plants," a thesis which enabled him to make a plea to biological students for more assiduous attention to morphological study as the essential foundation of experimental work in biology. He reminded his audience that it was the host of workers who patiently observed and compared the facts of individual development, particularly in plants of low organization, who prepared the field for the magic touch of Darwin to produce the theory of descent. This is not the place to summarize the whole of Professor Bower's address; it must suffice here to say that he communicated to his audience, through the beauty and simplicity of the illustrations he used, some of his own enthusiasm for an attitude towards biological studies which has for some years past been regarded as unnecessary drudgery by some representatives of the modern school of experimentalists.

The President concluded his address by referring to the gloomy prophecy made in 1898 by Sir William Crookes, on the occasion of the last meeting of the Association in Bristol, that by the year 1931 there would be a world food shortage. That this catastrophe had been averted was due to the successful application of the results of botanical and other scientific research to the production of the necessaries of life, a fact which alone justified the creation and expansion of research services throughout the British Empire.

### Government Research.

Professor Bower's necessarily brief sketch of the ways in which the various governments of the Empire are fostering research was elaborated most appropriately by no fewer than five official members of imperial research institutions, each of whom occupies the position of president of a section of the Association. They are Dr. F. E. Smith, secretary of the Department of Scientific and Industrial Research; Dr. G. T. Morgan, director of the new Government Chemical Research Laboratory; Dr. A. W. Hill, director of Kew Royal Botanic Gardens; Dr. W. T. Calman, keeper in zoology at the Natural History Museum; and Dr. P. J. du Toit, director of veterinary services and animal industry for the Union of South Africa. That five out of thirteen section presidents should be in the direct employment of the government is some indication of the place which government research institutions occupy in the world of science.

In his address to the Mathematical and Physical Section on "Theories of Terrestrial Magnetism," Dr. Smith pointed out that our knowledge of the cause of the earth's magnetic field is little more than conjectural, for, of the theories advanced, all that have been put to practical test have been found wanting in some respect. The subject, of course, had a direct bearing on radio communication, and its further elucidation depended on the accuracy of observations made over the whole world during magnetic disturbances. Dr. Smith therefore appealed

for international co-operation in the adoption by many of the first-class magnetic observatories of a programme including simultaneous observations with similar instruments of great sensitivity.

The need for such international co-operation was supported by Professor Appleton, who, together with Mr. Watson-Watt, Monsieur Bureau (France), and Dr. Connolly (America), took part in a discussion on the "Meteorological Relations of Atmospherics," in which it was pointed out that the divergent views of certain British and American physicists on the origin of atmospherics was probably due to the dissimilarity of the instruments used for observation. In this connexion Professor Appleton suggested that the universal use of the oscillograph, which had been designed by Mr. Watson-Watt and his colleagues at the Radio Research Station for the location and intensity of atmospherics, would solve the problem of the origin of these disturbances.

### Chemical Investigations.

Dr. Morgan's presidential address to the Chemical Section dealt with the results of the six major investigations which have been carried out under his direction at the State Chemical Research Laboratory at Teddington. The production of synthetic resins of high dielectric capacity have been obtained from formaldehyde and the cresols and xylenols, and fresh information has been disclosed concerning their chemistry. A systematic study has been made of the chemical constituents of the tar derived from low temperature carbonization, a result of which has been the isolation from this and other tars of four chemical groups of resins. Investigations have been made on the effect of high pressure on chemical reactions, and many members of the homologous series of alcohols, aldehydes, fatty acids and esters have been synthesized by the interaction of carbon monoxide and hydrogen in contact with various catalysts at high temperatures and pressures.

Other investigations described included those on the corrosion of metals either in air or when immersed in water or salt solutions, resulting in two noteworthy discoveries regarding the composition of the green patina which develops on exposed copper surfaces. Work on the base-exchange (zeolite) method of water softening was also described. Of all the work in progress at the Laboratory, however, that being carried out in collaboration with the chemotherapy committee of the Medical Research Council may have far-reaching effects on the preparation of drugs, essences and perfumes, on a commercial scale in this country.

Under the somewhat forbidding title "Problems in Taxonomic and Economic Botany," Dr. A. W. Hill delivered an illuminating presidential address to the Botany Section. He strongly supported Professor Bower's plea for the systematist by emphasizing the importance of accurate records in connexion with work on genetics, hybridization, acclimatization, and the influence of soil content on plant growth. In his survey of the work carried out under his direction at Kew he mentioned that it was from records compiled there upon information obtained from all parts of the world that it had been ascertained that the musk plant (once a feature of our gardens in England, and with which the musk scent was uniquely associated) suddenly and almost simultaneously, wherever it was grown throughout the world, had ceased, a few years ago, to give out this scent, a phenomenal occurrence which indicated a fascinating subject of inquiry.

Dr. Calman's presidential address to the Zoology Section on "The Taxonomic Outlook in Zoology" was a further and closely reasoned appeal for more and better work on systematics, from the lack of which, he asserted, much current work and speculation in biology has suffered. Dr. Calman's critical examination of Professor Przibam's theory of apogenesis, which suggests that every species has developed, independently of all others, from a distinct species of protozoan, with its implied doctrine of special creation at one remove, was a particularly challenging feature of his address.

### Veterinary Achievements.

Dr. du Toit, upon whom the mantle of Sir Arnold Theiler of rinderpest fame has descended, gave a general outline of some of the most notable achievements in veterinary science in recent years, in collaboration with investigations in other sciences. On all fronts the campaign against diseases in domesticated animals is being waged with ever-increasing success, due to scientific methods supplanting the older empirical methods. Progress is being made in the treatment by drugs of animals infected with disease transmitted by tsetse flies, the scourge of African cattle and the menace to African civilization; the fight against diseases caused by piroplasms is now being waged with every hope of success now that the role played by the "tick" in their transmission is fully understood. Great advances have been made in connexion with the groups of diseases due to ultra-visible viruses and recent studies have led to the evolution of methods for their eradication or cure; the eradication and control of diseases caused by external parasites and poisonous plants; the effect of mineral deficiencies

in the soil on animal nutrition; and in animal breeding.

In his address to the Geology Section on the "Geological History of the Bristol Channel," Professor Jones provided a sound basis for the field studies of visiting geologists. Of particular interest was his statement that "comparison of the physical features in relation to axes of folding leads to the conclusion that those in the west of England are together almost a mirror image of those in the east." Sir Ernest Moir's address to the Engineering Section profusely illustrated the interdependence of the engineer on the science of the physicist, the physiologist, the bacteriologist, the economist, and the all-important science of finance. The most technical of the presidential addresses was that of Professor Raper to the Physiology Section on "The Synthetic Activities of the Cell," the popular exposition of which is admittedly exceedingly difficult. To the Anthropological Section its president, Dr. Harrison, of the Horniman Museum, presented his conception of the evolution of material culture in an address which combined in the happiest way lucidity, scholarliness and charm. Professor Roxby, president of the Geography Section, dealt with the scope and aims of Human Geography, and Professor Valentine, who addressed the Psychology Section on "Foundations of Child Psychology," indicated the scope of the future activities of investigators in their respective branches of study.

### Higher Education.

Neither Lord Eustace Percy, president of the Education Section, nor Professor T. E. Gregory, president of the Economics Section, were at Bristol to deliver personally their respective addresses. Lord Eustace was in America, and Professor Gregory was with Sir Otto Niemeyer in Australia. The former's contribution on "A Policy of Higher Education" was a fuller exposition of views he had already outlined in Parliament on the compulsory raising of the school-leaving age. He challenged the truth of the assumption that full-time schooling up to sixteen years of age must be good for everyone, and that all we require is a sufficient variety of schools and curricula, an assumption which he asserted ignores the fact that higher education worthy of the name is the very antithesis of the "forcible feeding" largely and necessarily prevalent in the elementary stage. At the same time he agreed that there is an increasing demand in the country for labour involving some measure of abstract thinking and planning, which points to longer schooling. This demand, he suggested, can best be met by the development of five-year courses for children between eleven and sixteen, the first three in full-time schools and the last two either in full-time or part-time schools according to the pupil's needs.

Professor Gregory's subject, "Rationalization and Technological Unemployment," was equally controversial, although presented less provocatively. Rationalization, he suggested, is not a remedy for unemployment. On the contrary, it might increase its volume. But the rationalization movement was international in character and this country certainly could not contract out of its consequences. The consequences might be that the occupied population of the future would be less industrialized than in the immediate past. In this transition a grave transfer problem was involved, and therefore the first and most obvious ameliorative measure must be an increase in the mobility of the working population.

### Popular Lectures.

As usual, the Council of the Association arranged for a number of popular and semi-popular public lectures on subjects of general interest in the place of meeting and neighbouring towns. These included lectures on "The Sun" by Mr. Greaves of the Greenwich Observatory; "Price Level and Scientific Control" by Sir Josiah Stamp; "Breathing under Difficulties" by Professor Winifred Cullis; and an address by Dr. Stefannson on "Bristol and the Exploration of Greenland." In the first evening discourse to the members of the Association, Professor Appleton gave a characteristically vivid and clear exposition of an exceedingly difficult subject, "Wireless Echoes," phenomena which are annoyingly familiar to most users of wireless sets, but which open up a field of inquiry of intense interest to physicists. Dr. R. E. Slade, at the second evening discourse on "The Nitrogen Industry and our Food Supply," gave an account of the commercialization of the process for extracting nitrogen from the atmosphere, with particular reference to the output from Billingham of fertilizers based on this process, and gave statistics to show how the synthetic products had, in a few years, become the preponderating factor in the world supply of nitrates.

There were rather fewer joint discussions than usual between sections, only four taking place. In two of these, one on the "Relation between Past Pluvial and Glacial Periods" and the other on "Primary Colours," the various expert contributors were inclined to be either too technical or too discursive. Very different was the discussion between the Engineering and Physiological Sections on

" Air Pressure Variations in Engineering Works and their Physiological Effects," in which views were exchanged between naval and marine engineers in charge of salvage operations involving deep-sea diving, engineers engaged in tunnelling, and physiologists and medical men engaged to safeguard personnel subjected to high air pressures. The discussion on " Mineral Elements in Plant Nutrition " between the Botany and Agriculture Sections was not only intrinsically interesting but fruitful in indicating the lines on which further advances in knowledge might be made.

### Individual Sections.

In the individual sections a number of discussions took place. In addition to one on " Atmospherics," to which I have already referred, the Mathematical and Physical Section discussed " Flow in Gases," where the various methods of its determination were under review, another following a series of papers on " The Solid State," which was the occasion for Sir Ernest Rutherford's announcement that experimental evidence was now available to prove what had been for a long time suspected, that the streams of apha-particles emitted from various radio-active elements were complex in character. This announcement, Sir Oliver Lodge remarked, would throw light on the constitution of the atomic nucleus. In this connexion, the paper by Dr. P. A. M. Dirac on " The Proton," in which he put forward an hypothesis of the proton which could be reconciled with the Principle of Relativity and the Quantum Theory, attracted a great deal of interest, and further enhanced the author's reputation as one of the most brilliant of our younger physicists. Another item on the programme was a paper by Dr. Milne, in which he gave his reasons for regarding Professor Eddington's and Sir James Jean's estimate of the temperatures of the interior of the sun and stars as much too low.

The discussion in the Chemistry Section on the present position of the British Dyestuff Industry appropriately took place immediately following the official issue by the Board of Trade of a review of the operation of the Dyestuffs (Import Regulation) Act which expires on 15th January, 1931, unless the Government decides otherwise. The discussion provided chemists, manufacturers and users of dyes with an opportunity of showing the commendable progress which has been made in dyes production in this country since 1914. A discussion on " Chemotherapy " in the same section also took place. This section provided the sensation of the week, the paper by Dr. M. Nierenstein on the " Pyryllium Series," in which he challenged the views of other chemists regarding the identity of pyryllium compounds derived from plants with the synthetic products, exciting a controversy and an exchange of courtesies more in keeping with a political meeting than a gathering of scientific experts.

In the Geology Section there was a discussion on the " Validity of the Permian as a System," a very technical subject but most interesting from the varied character and increasing volume of data which protagonists of different schools of thought have accumulated. Professor Abercrombie's opening contribution to the discussion in the Geography Section on " Satellite Towns " attracted much attention, as well as his and Dr. Vaughan Cornish's addresses on " National Parks " to the Conference of Delegates of Corresponding Societies, to which body also an appeal was made for help in establishing local Folk Museums as well as the proposed National Folk Museum in Regent's Park. The Economics Section rendered a distinct service by arranging a discussion on the " Value and Limitation of Costing in Industry and Agriculture," to which representatives of the Agriculture Section contributed and in which it was pointed out that an elaborate system of costing often defeats the object for which it was devised. And much that was valuable was said in the discussions in the Agriculture Section, among which was an address on the " Influence of Fertilizers on Yield and Composition of Plants."

### Mr. Bernard Shaw Present.

Three other contributions call for special mention. The account of Mr. C. V. Dawe on the work in agricultural economics at Bristol University demonstrates that the willing co-operation of farmers in experiments and costing accounts benefits agriculture and science alike. Dr. J. F. Tocher's paper on the " Adulteration of Milk with Water " will cause public analysts some concern because Dr. Tocher's results are decidedly disturbing. Lastly, Sir Frederick Keeble's paper on " Agricultural Problems in South Africa " gave an account of experiments with fertilizers in different districts, and expressed his belief, by no means allowed to pass unchallenged, that mineral deficiencies in the soil rather than shortage of water are the cause of South Africa's pastoral troubles. To this paper the presence of Mr. George Bernard Shaw gave piquancy and brought to the Agriculture Section an audience which might otherwise have missed the opportunity of hearing one of the most interesting discussions of the whole meeting.

# Exploring the Atmosphere by Air-waves.

**By F. J. W. Whipple, M.A., Sc.D.**

*Superintendent of Kew Observatory.*

*The propagation of air-waves is now being studied as a means of discovering more about the upper atmosphere. The method consists in noting the times at which the waves produced by distant explosions are registered, and was the outcome of experience of the audibility of gunfire during the war. There is much scope for experiment in this important branch of scientific research in all parts of the world.*

THE experimental study of the propagation of airwaves to great distances began soon after the end of the war. As noted already in *Discovery**, it had been known since the days of Pepys that sounds were sometimes to be heard at very great distances from their origins whilst there was silence in the intervening regions. The first detailed examination of such phenomena was made by a German scientist, von dem Borne, who collected information about the audibility of a great explosion which occurred at Förde, in Westphalia, on 14th December, 1903. A dozen opportunities for such investigations followed, and in every case it was found that there had been an inner zone of audibility and one or more outer zones separated by regions where nothing had been heard.

### An Early Theory.

Such a remarkable distribution of audibility called for explanation, and von dem Borne put forward the theory that the phenomena were due to the refraction of the airwaves after they had penetrated the atmosphere to an enormous height. He realized that to make the waves turn over and return to earth there must be a stratum of air in which the velocity of sound is very great. Accepting current views as to the constitution of the atmosphere, he attributed this great velocity to the high proportion of hydrogen in the air at heights of 90 kilometres or so above ground. According to this theory the track followed by the energy was horse-shoe shaped. The sound left the ground and returned to it almost vertically.

Von dem Borne's theory was not accepted by all investigators. Some thought that if only we had enough knowledge of the air currents at moderate heights it would be possible to demonstrate that the sounds had been brought down by wind. It was clear that to test this hypothesis it would be necessary for an explosion to occur at a time when very complete information about the upper winds was available. At the end of the war the time was ripe for experimental controlled explosions. The initiative was taken by Prof. A. de Quervain, a Swiss meteorologist, who had himself made several investigations of abnormal audibility. He had studied the audibility in Switzerland of the firing on the western front, and some years previously the audibility of an explosion which occurred when the Jungfrau railway was under construction. Unfortunately de Quervain did not live to discuss the results of the experiments made at his suggestion under the auspices of the International Meterological Committee. The first experimental explosion was at Oldebroek, in Holland, in October, 1922, and this was followed by a series of explosions at la Courtine, in Central France, in 1924. It was between the dates of the Oldebroek and la Courtine explosions that the clue was found to the explanation which is now generally accepted for abnormal audibility.

### The First Clue.

In a discussion of observations of shooting stars, Lindemann and Dobson came to the conclusion that the density of the atmosphere at the levels at which the luminosity is produced must be greater than current theory allowed. The explanation they gave was that the air below these levels must be very buoyant, that the buoyancy was due to high temperature, and that the high temperature was due to the selective absorption of solar radiation by ozone. As was pointed out soon after Lindemann and Dobson's paper appeared, the application of this theory to the problem of abnormal audibility was obvious. Whereas von dem Borne had suggested that the critical high velocity of sound was due to the excess of hydrogen in the atmosphere, the new explanation was that the high velocity was due to excessive temperature.

In studying the audibility of explosions which occur without warning we have no accurate knowledge of the time the sound takes to reach the observers.

* "The Problem of Abnormal Audibility," by C. Britton, M.Sc., April, 1928.

When an explosion is produced for experimental purposes, the time of passage of the sound from source to observer can be found accurately. This is of great assistance in interpreting the observations. The la Courtine observations proved favourable to the Lindemann and Dobson theory, but indicated that the transition from the low temperature of the atmosphere to the high temperature above was lower in the atmosphere than those authors had postulated.

### German Research.

In Germany research on the subject has been carried on vigorously. The stimulus was given by Prof. Wiechert, the distinguished seismologist, and the first explosion was at Jüterbog on 3rd May, 1923. Two reports prepared by H. Hergesell and P. Duckert of the aeronautical observatory at Lindenberg include details of no less than 346 experiments carried out on seventy-one days, the latest on 26th March, 1929. To begin with, large quantities of explosive were used, and the observations were mainly by ear. Instruments suitable for recording the airwaves, whether audible or not, were soon developed, and came into use in increasing numbers. By 1928 twenty-nine instruments, mostly of the pattern invented by Prof. Kühl, and known as the undograph, were in use. These were distributed according to an ingenious system. They were placed approximately on a line passing from north-east to south-west through the place, Jüterbog, where the explosions were to be produced. It was realized, no doubt, that it was better to use the available apparatus to get observations which would serve to define the properties of a vertical section of the atmosphere, rather than to make an attempt at a broader picture.

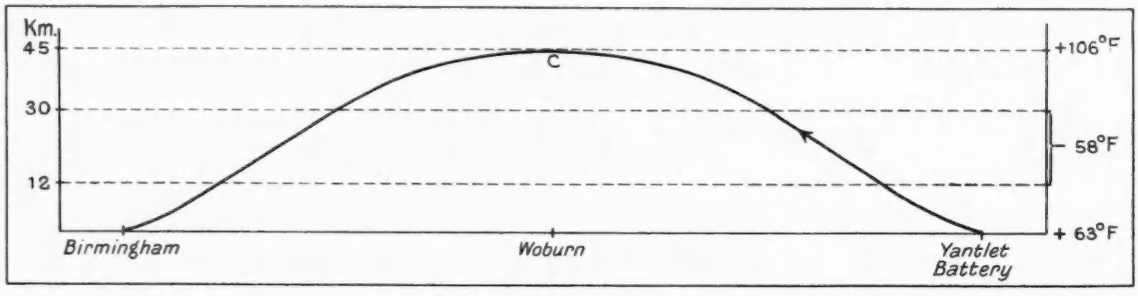
Of the three experiments made in this way, the first, that of 17th July, 1928, yielded good observations mostly to the south-west of the source of the waves. That of 19th December, 1928, yielded observations to the north-east. Waves from the third, on 26th March, 1929, were recorded in both directions. Records were obtained at Königsberg at the great distance of 578 Km.

In England we have been working on a more modest programme, but the results which have been obtained are of considerable interest. Attention has been concentrated on the airwaves produced by the discharge of guns. The waves have been recorded by hot-wire microphones. These instruments were developed during the war for "sound ranging," the location of hostile artillery. The apparatus has the advantage that the records from several microphones can be made on one strip of photographic paper. As an illustration, one of the records of the reception at Birmingham on 2nd August, 1928, is here reproduced. The objects of multiplying the records are to demonstrate that the waves are coming from the right direction, and to determine the angle of descent.

### British Observations.

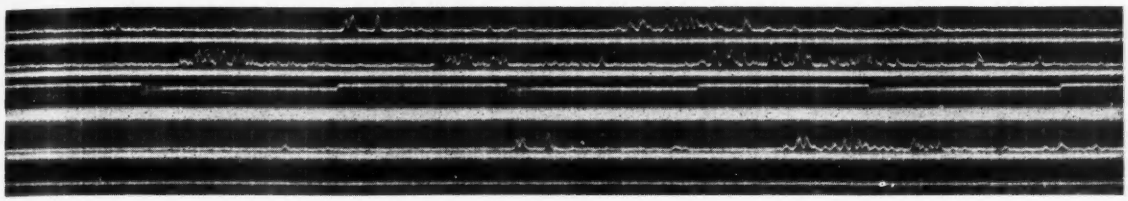
There are now microphones at six stations, Birmingham, Bristol, Cardiff, Exeter, Nottingham, and Sheffield. Up to the present the exposure at Exeter has not been satisfactory; the microphones are disturbed by traffic. Airwaves have been received at all the other stations, from Shoburyness, or from Yantlet on the other side of the mouth of the Thames, or from Woolwich. In obtaining the records we have had the co-operation, not only of the military authorities, but also of the British Broadcasting Corporation, by whose courtesy signals are broadcast from Daventry during the firing. The research is one which makes great demands on the patience and skill of observers, and I cannot let this opportunity pass without expressing my appreciation of the pains which have been taken at all the co-operating stations to secure reliable results.

All the successful observations have been made




THE ROUTE TAKEN BY THE AIR-WAVES.

The time taken by the waves to travel from the gun to the microphones is compared with the time which sound would take to travel along the ground. In this example the sound would have taken 615 seconds to travel the 210 Km. from Yantlet to Birmingham while the waves took 711 seconds, and were therefore delayed by 96 seconds.



AN ACTUAL RECORD OF AIR-WAVES.

One of the records of the reception of air-waves at Birmingham is here reproduced. In England, attention has been concentrated on the air-waves produced by the discharge of guns, and the waves have been recorded by hot-wire microphones. The apparatus records from several microphones on one strip of photographic paper.

in the summer months. There have been trials in September and the winter half of the year, but no certain case of reception of the airwaves. The experience of war-time, when the firing on the western front was heard in England only in the summer months, has been paralleled.

### Registering Disturbances.

It should be noted, however, that although the apparatus was designed for "sound ranging" the disturbances which are registered need not be audible. In fact, the observers have never reported any sounds which they could attribute to the firing. We know from the observations the time taken by the waves to travel from the gun to the microphones, and it is natural to compare this with the time which sound would take travelling along the ground. We calculate this time (neglecting the wind) and determine the interval by which the waves have been delayed. For example, on 9th July, 1927, the temperature was 18°C., and sound would have taken 615 seconds to travel the 210 Km. from Yantlet to Birmingham. The waves took 711 seconds, and were therefore delayed by ninety-six seconds. In most cases the delay does not differ much from 100 seconds. It should be mentioned that in a trial lasting for an hour or two the times recorded are very consistent. The best examples of this consistency was on 17th July, 1928, when the times for eight rounds observed at Bristol agreed to a second.

The angles at which the airwaves descended have been determined on many occasions. Birmingham has been most successful. Angles exceeding 20° occur frequently. If we could detect the waves with our ears the sounds would seem to come from well up in the sky. On several occasions the records at Birmingham have shown a succession of separate waves. Generally it has been found that the first of these waves comes down at a small angle, and the last at a much larger angle. There was, however, one occasion, 11th July, 1929, when at the range of 174 Km. the first wave came down at 35° and the following wave eight seconds later at 22°.

Now let us turn to the object of these experiments—the exploration of the upper atmosphere. Consider in the first place the sort of trajectory described by the airwaves. We ignore the influence of wind, and remember that in the lower atmosphere temperature falls off as we ascend so that the velocity of sound falls off also. In the stratosphere, which is entered at a height between 9 and 12 Kms., temperature may be taken as uniform. The passage of a wave through a medium in which the wave-velocity varies may be compared with that of a line of men marching over rough ground. When the men on the right flank march faster than those on the left the line wheels to the left, and the path travelled by one of the men curves to the left. So when an elementary wave is passing through the lower atmosphere, the trajectory, or sound-ray as it may be called, curves upwards. In the stratosphere the wave goes right ahead, the sound-ray is straight. If the wave is to come to earth again there must be a region in which the velocity of sound is greater above than below. In the sketch shown the wave reaches the highest point at C, and then completes a symmetrical curve.

### A Simple Rule.

There is a simple rule which holds good with all such trajectories, *viz.*, the velocity of the wave at the top of the trajectory is equal to the final velocity of the wave along the ground. The only proviso is that the stratification of the atmosphere must be horizontal.

Now the velocity of the airwave along the ground is just what we measure when two microphones in action at the same station are in line with the source. For example, at Birmingham on 2nd August, 1928, waves originating at Yantlet came down at an angle of 16°. The apparent velocity of the waves along the ground was 355 metres per second. We deduce that at some height in the atmosphere this was the velocity of the airwaves. However, we cannot determine how much of the velocity was due to high temperature. The temperature corresponding with a velocity of 355 metres in still air is 106°F. If the air had a velocity

of twenty metres per second from south-east the relative wave velocity was only 335 metres per second and the temperature 45°F. To account for a return of the waves to earth entirely by wind whilst supposing the temperature to be that of the stratosphere (223°A. or −58°F.), we should have to postulate a wind of no less than fifty-six metres per second.

The height which the waves reach before they return to earth cannot be estimated as readily as the velocity. We know, however, how fast the waves are travelling until they reach the stratosphere, how fast they are travelling at their highest point, and how long they take on the journey. We cannot go far wrong in estimating the height of the turning point. In this case of the waves which came down at Birmingham at 16° the turning point was about 45Km. above the ground. The waves which reached Birmingham on the same day with a very small angle of descent had turned at about 40Km., whilst the waves which came down at Bristol at 27½° had been to a height of 55Km. These results are typical.

### Influence of the Wind.

Our English observations having been made only to the north and west of the origins of the airwaves, the question how large a part a wind plays in bringing the waves back to earth cannot be answered. It is likely, however, that there is between 40 and 55 Km. wind from some point between south and east during the summer months. The German observations lend considerable support to the hypothesis that there is a monsoon-like effect, the wind reversing in spring and autumn. With the stations mostly to the north-east and south-west of the explosions, airwaves have been recorded most frequently to the north-east in winter and to the south-west in summer. As a case of transition we note that on 26th March, 1929, there was good reception on both sides of Jüterbog and, moreover, that at places between 196 and 308 Km. the delay as compared with a standard of three seconds per kilometre was about the same (100 seconds) in both directions. Such symmetry implies that the wind in the higher atmosphere exerted little influence. The high velocity of the airwaves at the top of the trajectories must have been due to high temperature. It is reasonable to suppose that in other cases temperature is the most important factor.

The hypothesis of Lindemann and Dobson that the warmth of the atmosphere at great heights is due to the pressure of ozone has been closely investigated by Dr. E. H. Gowan. The quantity of ozone is exceedingly small (it would make a layer only 3 mm. thick if it could be collected and brought down to the ground) but Dr. Gowan finds that it would suffice to gather the thermal energy from the ultraviolet rays from the sun and warm up the air with which it is mixed. In recent years much attention has been devoted to the variations in the quantity of ozone in the atmosphere. It remains to be seen whether these variations can be correlated with the changes in temperature and in aircurrents revealed by the study of airwaves. There is scope for observation and experiment in all parts of the world.

## New Light on the Origin of Man.

ARCHAEOLOGICAL discoveries in Africa throw interesting new light on the problem of man's place of origin. The illuminating suggestion that Kenya was nearer the place of origin than Europe was recently made by Mr. L. S. B. Leakey, leader of the East African Archaeological Expedition of 1926-9, in a lecture at the Merchant Venturers' Technical College. The development of the Stone Age cultures in Kenya, he said, was intimately bound up with the climatic changes, and a remarkable fact was that, with certain very important exceptions, the culture sequence in Kenya was identical with that in Europe. The earliest well-defined European culture was that known as chello-acteulean, and although Kenya was several thousand miles away from Europe the tools of this period were so similar to those of this culture in Europe that they could only be distinguished by their difference in material.

From the beginning of the second main pluvial period onwards there was clear evidence that in Kenya, unlike Europe, the Mousterian and Aurignacian cultures existed side by side, each developing along its own lines. The Kenya Mousterians appeared to be as primitive as their European cousins, but the Aurignacians, on the other hand, had a well-developed culture, and from their skeletons it was known that they were definitely ancestors of modern man.

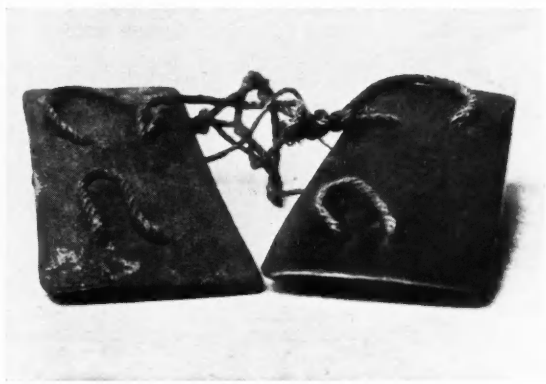
It was in connexion with this contemporaneity of the Aurignacian and Mousterian cultures in Kenya that the question of the exact correlation of the glacial periods of Europe and of the pluvial periods of equatorial Africa became so important. With the evidence as it stood at present, it looked as though the long interglacial period which separated the two pairs of glacial advances in Europe should be correlated with the long interpluvial which separated the two big main pluvial periods in Africa, and if this were correct correlation, the Aurignacian culture started very much earlier in Kenya than in Europe.

# Across Bolivia.

**By J. C. Bee-Mason.**

*As a member of a recent expedition, the author was able to explore the dense forests of the Bolivian wilds, and gives a first-hand account of the hazardous journey to the Andes. Untold mineral wealth lies dormant in the "chaco," and awaits the enterprise of the white man.*

WHEN Senor Mamerto Urriolagoitia, the Bolivian Consul-General in London, decided recently to organize an expedition across Bolivia, from the Paraguay River to the Andes, it was arranged that Julian Duguid, a graduate of Balliol College, should accompany him as chronologist, and I was engaged to make a film record. The first stage of our journey took us via Buenos Aires and the Parana and Paraguay Rivers to Lake Gaiba, near the Brazilian frontier. Here we were joined by Alexander Siemel, whose skill as a professional jaguar-hunter made him a welcome asset to the expedition. We were delayed for some weeks at Gaiba owing to the difficulty in obtaining horses and mules, but eventually we made a start with two horses, two mules and twelve oxen, and our provisions and baggage. Four natives were engaged to accompany us. We followed an Indian trail running almost due west in the direction of Santo Corazon.



TOBA FOOTWEAR!

Utility appears to be more important than comfort to the Toba, whose sandals consist of wooden boards, with ropes in which the ankle and toes are placed. This pair was worn by a savage captured in the Bolivian chaco.

This part of South America was known to the ancient Incas, who named it *Chaco*, or hunting ground. The country is undulating, in places thickly wooded, in others prairie land, known locally as *Camp*. Here the native cattle have unlimited pastures, and cotton and tobacco plants grow wild. Our natives dried the leaves and made us cigarettes by rolling the tobacco in maize leaves. Near the Paraguay River the chaco abounds in wild duck, and the sportsman will find jaguar, wolf, fox, wild boar, deer, turkey, quail, partridges, and a host of smaller birds.

When three days from Lake Gaiba, Siemel spotted the tracks of a jaguar, and soon after a fine specimen fell to the gun of Senor Urriolagoitia. At Santo Corazon we remained for some days to rest our mules, and here exchanged the oxen for additional mules. We found our progress with the oxen far too slow, and wished to get through to Santa Cruz before the rainy season set in. This Indian village was established by Jesuit missionaries three or four hundred years ago. When they arrived the natives were naked savages, but the women were taught by the missionaries to wear long white overalls reaching to the ankles, and, although the Jesuits were expelled from Bolivia a hundred and fifty years ago, the women are still attired in long white overalls. Modesty, in fact, had been carried to such an extent that in a Jesuit temple we found a crucifix with the figure of Christ draped, also, in a garment reaching to the ankles. In this temple were many intricate carvings, and a prayer book from the private press of Balthasar Moreto of Antwerp, dated 1689. Duguid was anxious to possess the book, and suggested to Urriolagoitia that he ask the priest if he would part with it, provided that a sum of money were given to the church. The old Indian stood erect, and with great dignity said, "The church is not poor; we have six hundred head of cattle!" It was evident that any attempt to purloin the book would have ended disastrously for ourselves; it is certain that we should not have left the village alive. The natives here are known as the Chiquitanos Indians. They seemed unusually intelligent, doubtless as a result of the Jesuit occupation. The women were extremely industrious, and were busily engaged in weaving garments on looms, the cotton being spun by holding the spool between the toes.

We left Santo Corazon for San José, but instead of following the Indian trail we took a northerly course. This was the most difficult and strenuous part of the whole journey. For the next three hundred miles we cut our way through virgin forest, sometimes only progressing three miles in one day. In this part of Bolivia we were impressed by the wide variety of tree and shrub life, including quebracho, cedar, ebony, palm, acacia and mimosa; but we saw very few animals or birds. We had started at the close of the dry season; rivers were dried up, and the game had gone elsewhere in search of water. We had to search the river beds until we found soft mud in dense shade, fill our handkerchiefs with the green slime, and squeeze out what moisture was there to make tea, coffee, or soup. We were distressingly short of food, and only ate one meal of dried meat and rice every twenty-four hours: we maintained our strength by drinking Yerba maté, made from the leaves of a tree which grows wild in parts of South America. The leaves, when dried in the sun, are placed in a seed pod, boiling water being poured over them. The tea is drunk through a *Bombilla*, or silver tube. Maté is now being cultivated extensively in Paraguay and exported to Europe, where it is sold as Paraguayan tea. It is very sustaining, and Indians are able to travel for days without food, drinking only maté. In the dry district we were troubled by a small bee, known locally as the "Sweat" bee. It has no sting, but clings to one's face, neck and wrists, absorbing the perspiration. At one place, they invaded our dinner plates in enormous numbers, and one night an army of red ants found their way into a tree where my hammock was slung and descended upon me, covering me with blisters the size of a penny.

THROUGH VIRGIN FOREST.

The journey from Santo Corazon to San José was the most strenuous part of the whole expedition. Instead of following the Indian trail a northerly course was taken, and a route had to be cut through three hundred miles of virgin forest.

After many weeks we arrived at the Indian village of San José, where we remained for about ten days. We were still a hundred and eighty miles from Santa Cruz. The Indians warned us that the district beyond was swampy and abounding in insect pests. We had not proceeded very far when we reached the swamps, and for the greater part of the journey during the next ten days our animals trudged through the mud. The insects were extremely troublesome; huge mosquitoes stung through our riding breeches, and we and our animals were badly bitten by horseflies. We saw poisonous spiders six inches in diameter; they are able to jump six feet and feed upon small birds and mice. At night the air was filled with millions of tiny insects, almost invisible to the naked eye. They penetrated our mosquito nets at night so that sleep was impossible. All through the night we walked up and down by the light of the moon, waving branches for protection.

After we had cleared the swamps, we discovered that we were being followed by about fifty Toba savages, a race which roams the forest in the southern part of the chaco. They followed us for many miles, and caused us considerable discomfort. At night, fearing an attack, we made a barricade with our baggage. Unknown to us, they poisoned our waterhole. Before leaving the next day, we went to fill our water bottles and found that they had stirred up the mud with branches which they had left lying about. We waited two hours for the water to settle before filling our bottles. A few hours later we were all taken seriously ill, with the exception of Duguid, who did not drink the water. We discovered later that the savages had poisoned the water by squeezing into it the juice of berries from which Croton oil is made. We were told afterwards that this is a well-known trick of theirs. On the following day, when a friendly Indian was struck on the head by a Toba arrow and seriously injured, Siemil shot one of the savages, and I brought home his sandles as a souvenir.

Ultimately we arrived at the Rio Grande, which had to be crossed before reaching Santa Cruz. The river is a tributary of the Mamore, which flows into the Amazon. All our baggage had to be unloaded and taken across the river in floats made of cowhide. The wagons were then taken over. This occupied the whole of one day. Three days later we arrived at Santa Cruz, and we then decided to pay off the natives who had come through with us from Lake Gaiba. As they were reluctant to pass through the

district occupied by the Toba savages, we gave the leader a rifle which he had learned to use.

It was our intention to proceed from Santa Cruz to Sucre, the legal capital of Bolivia, but the natives warned us that the route was dangerous owing to abnormal rains. We therefore decided to turn south through the forest, down to the Argentine frontier. An American contractor had been cutting a road through a part of the forest for the Bolivian Government, and he kindly lent us a motor lorry. We hoped to make a journey of two hundred miles in three days, but it rained every day and the journey actually occupied nineteen days. Time after time the car sank axle deep in the mud. We had to unload, jack the car out of the mud, strew branches on the ground over which we pushed the car on to firmer ground, then carry our baggage through the mud and rain to reload. This occurred on an average every three miles. When we had pushed the car for nearly eighty miles we decided to abandon it, and left it in the middle of a river continuing the journey on mules.

THE TEMPLE AT SAN JOSÉ.

The seventeenth century Jesuit temple was the centre of an early campaign of rigid reforms. The temple still prospers, although the Jesuits have long been expelled.

Before reaching the Argentine frontier we crossed the Parapiti, or "River of Death," the most dangerous in the whole of South America. Frequently the water suddenly rises at least ten feet without any warning, owing to storms in the mountains perhaps a hundred miles away. We had to undress, tie our clothes on our heads and swim across, the natives taking our baggage. I swam across first, while two picked Indians carried my camera and tripod. Senor Urriolagoitia followed. Before Duguid and Siemil could cross a wall of water six feet high came down and the river was soon a raging torrent. It was four days before our friends could rejoin us.

Two weeks later we arrived at Yacuiba, on the Argentine frontier, having penetrated eight hundred and fifty miles of forest. From Yacuiba the journey took us through picturesque country, dotted with farmsteads. Instead of forests and swamps, we now traversed rolling pastoral country, ideal for cattle raising. We turned eastward to Tarija, a town with a population of ten thousand, and situated six thousand feet above sea level. Near the town several perfect skeletons of the masterdon have been found. We saw a portion of one skeleton near the river, and I secured a part of the jaw with four perfect teeth and also a piece of tusk. About sixteen miles north of Sucre, a landslide had occurred just before our arrival, disclosing a burial ground of the Incas. I obtained a small earthenware vase in perfect condition.

Sucre is a delightful city with a perfect climate. The heat is never oppressive, frosts are unknown, and being over eight thousand feet above sea level there are few insects. At Potosi we saw the famous silver mountain, from which £7,000,000 worth of silver has been extracted since 1545. We visited the famous Aramayo silver mines at Atocha, and the Patino tin mines near Oruro, from which over fifty thousand tons of tin is exported annually. We began to realize how rich in mineral wealth Bolivia is when we learned that she has in profusion tin, silver, nickel, antimony, copper, gold, zinc, bismuth, borax and oil.

In the past, emigrants flocked to the mountains in search of minerals, while the enormous resources in the forest were ignored. The Government now recognizes that untold wealth lies dormant in the "chaco." Where experiments have been made the finest coffee has been grown. The native cotton grows to a height of six feet and produces six to eight pounds of lint. Since the discovery of the valuable tanning properties which the quebracho wood contains, the value of this tree has increased enormously. During one part of our journey we passed through one of the largest quebracho forests in the world. For a hundred and twenty miles eighty per cent of the trees were quebracho. In the Gran Chaco seepages bear evidence of the presence of oil.

There is no doubt that insect pests have discouraged the white man, but what has been accomplished in other parts of the world can be repeated in the Bolivian chaco. Years ago, notices were exhibited at all British ports warning sailors against signing on for any ship sailing for Santos in Brazil, but to-day Santos is a health resort.

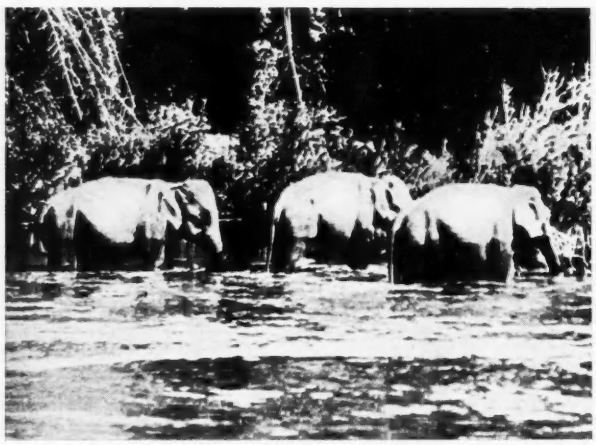
# Migration of Elephants.

**By Cyril Hopwood.**

*Formerly of the Imperial Forest Service.*

*A curious characteristic of the Lower Burmese elephant is that, unlike the species found elsewhere, it has developed definite migratory habits. The author, who was for two years in charge of the South Tenasserim Forest Division, has made a close study of the animal, and here reveals the reasons for this abnormal trait.*

ALTHOUGH Indian elephants roam in herds over a considerable area, and change their feeding grounds as may become necessary to ensure a sufficiency of fodder and water, they are not considered as being migratory animals in the usually accepted sense of the term. But where the frontier of Siam meets that of South Tenasserim, in Lower Burma, the elephants have developed very definite migratory habits.



IN SEARCH OF SALT.

At the beginning of October the herds break up, and the elephants make their way in small parties to the sea coast. Local opinion emphatically holds that the animals come there in search of salt, and the author thinks that this view is probably correct.

The animals which inhabit this area are a distinctly small race of the Asiatic elephant, the males rarely exceeding eight feet at the shoulder, and the females averaging about six feet, but mature animals of even smaller size are by no means uncommon. Further, the tusks of the males are never large, and many males are tuskless; *Hines*, as they are called locally. Although the possible connexion of small size with migratory habits has not been established, the point is of interest as showing a tendency to variation from the normal, and may indicate a step in evolution, though scientifically there is no distinction between the Siam-Tenasserim animal and the typical Asiatic elephant, all being referred to the single species *E. Maximus*.

Elephant catching is extensively practised in South Tenasserim, under licence from the Government of Burma, and as elephants are of great value to the Forest Department and the timber firms, they are rigorously protected. During the two years that I was in charge of the South Tenasserim Forest Division, I was called upon to advise the Government concerning the conditions under which licences were to be issued, and this work naturally entailed a close study of the habits of the animals. Personal observation combined with questioning of the native elephant catchers, some of whom were most intelligent men with a wealth of experience in this highly specialized art, elicited the fact that the elephants are only gregarious while living in the Siamese forests, east of the border, roughly during the months of April to September. I am not saying that no elephants will be found west of the boundary, that is, in Tenasserim, during this period, but they are far from numerous, though conditions of food and water would appear to be quite suitable.

About the beginning of October, the herds break up, and the elephants make their way singly or in small parties, rarely exceeding six or seven individuals, by well-known and clearly defined routes over the border. Their objective is the sea coast, and local opinion is emphatic in stating that they come there to eat salt. Probably this view is correct, for elephants in common with deer and other animals patronize the jungle salt licks in other parts of Burma remote from the coast, and although I have never seen elephants, or their spoor, actually on the beach, they certainly do come as far as the landward side of the mangrove swamps, and would have no difficulty in obtaining as much salt as they require from the brackish creeks that run from the coast for many miles into the forest.

Be this as it may, they certainly prefer the low-lying forest country, within a few miles of the sea, from October to March, and during this period they never form herds, though a few individuals may be found in company. A cow, with a calf at foot, is always solitary at this period of the year, as are the males. The small parties met with consist of young cows and calves of two to about five years of age. As soon as the hot weather commences, the return migration takes place, the beasts again travelling singly or in small parties, and only forming herds some time after they have reached Siamese territory. The habits of these elephants, and the now fully ascertained period of gestation of twenty-seven months, indicate that pairing takes place during the gregarious period, as newly-dropped calves are most commonly met with in October, which would place the actual mating date in July, that is, well after the herds had had time to re-form.

The methods employed to capture the elephants are peculiar, and have little in common with the keddah operations practised in India. Advantage is taken of the migratory habit, in fact, success depends upon an intimate knowledge of this. The trap, a miniature keddah constructed of stout saplings bound with cane, is placed upon a well-frequented route, and most carefully camouflaged. There is no driving beyond a very slight tapping with sticks far behind the elephants to keep them on the move, the object being for the intended victim to wander into the trap as it slowly follows the track; the traps themselves are designed to hold only a small number of animals. When one or more have entered the trap, they are secured by dropping a kind of portcullis, which has been suspended over the entrance by a cane. This is severed by a man stationed high up in a tree, allowing the gate to fall into position and to secure the captives. When more than one elephant is in the trap, it is for the operator to decide upon the ideal moment to drop the gate.

If cupidity gets the better of discretion, and too many are allowed inside, the chances are that the sheer weight of the terrified beasts will break the sides of the trap, and the reward of weeks of patient waiting will be lost. A bull elephant is on the average worth about three cows, and should a bull be the first to enter, the gate is dropped at once. Alternatively, if two or three cows enter and a bull is following, the gate is dropped so as to exclude him, as it is usually he that succeeds in breaking the wall of the trap unless captured singly.

I understand that in Africa it is a common practice to shoot young bulls to prevent them from leading cows out of the reserves. I do not think that this indicates a migratory instinct in the African species, but that it is merely the desire of a young bull to obtain lordship of a herd. The same tendency is found in the Asiatic elephant, and if the young bull is successful in forming a harem, but is not sufficiently powerful to defeat the existing lord of the herd, it is obvious that he must change his territory. In such cases as this the impulse would appear to be due to sexual rather than migratory instincts.

[*Indian Railways Bureau.*

THE CAPTURE OF A YOUNG BULL.

Elephant catching is extensively practiced in South Tenasserim and, as the beasts are of great value to the Forest Division and the timber firms, they are rigorously protected. The methods employed have little in common with the keddah operations practiced in India, but success in trapping depends upon an intimate knowledge of the migratory habit.

# The "Life Layer of the World."

*The study of the soil is a comparatively new but rapidly developing branch of geology. In an article in the American "Journal of Chemical Education," of which the following is a summary, Dr. R. R. McKibbin, of MacDonald College, Quebec, discusses the main groups of soil constituents, explains the effect of the climate on soil structure, and outlines the methods of classification adopted in America and Russia.*

THE only place where life of any kind can continue to exist on the earth is in a junction layer between what are known as the lithosphere, the hydrosphere, and the atmosphere. In the lithosphere there occur both water and gases, in the hydrosphere there are both solids and gases in solution, and in the atmosphere there are much water vapour and much finely divided solid matter. Wherever life occurs we find solids, water, and gas. Nearly all the land animal life, and practically all of the land plant life except the tops of trees, are in a state of nature concentrated in a soil and lower air layer of the world less than twenty feet thick. Some micro-organisms and many of the seeds of plants may survive for a long time in the atmosphere or deeper in the lithosphere, but they must eventually return to what may be termed the "life layer" of the world. It is as "the life layer" that I wish to define the thin outer soil layer of the land areas of earth.

### Systematic Classification.

Soil science is quite young. It is an offspring of geology. The first essential thing that must be done by any science in its own field is classification. The systematic classification of their soils is well advanced in many countries. The two leading countries of the world in this respect are the United States of America and Russia. In the United States, the classification of soils has chiefly been carried out by the Federal government working through the Department of Agriculture, and about fifty per cent. of the land area of the States has been classified into different soil provinces (or regions), series, and types.

The United States system of soil classification has been developed to take into account variations in the geological origin of the mineral portion of soils, climatic effect on soils, plant ecological variations, and many other factors which the skilled soil surveyor recognizes with ease in the field. Profiles (exposed sections cut down through soil and subsoil) of uncultivated land are examined and the number and thickness of the different layers in the soil are noted. Chemical determinations are made on each of the layers (termed "horizons" by the soil surveyors). The colour and texture of each horizon are examined. Areas having soils essentially alike are grouped together and an identifying name is given to the whole. Thus, "Sassafras silt loam" and "Leonardtown silt loam" are different areas of soil occurring in the Atlantic Coastal Plain province, of Sassafras and Leonardtown series, respectively, and both of silt loam type. There are important chemical and physical differences between these two kinds of soil which are reflected in the nature of the crops best adapted to each, in their relative need of specific fertilizers and in their natural mechanical condition.

### Preparing Maps.

The final result of the soil survey of a given unit of area (generally a county) is the publication of a description of the soils occurring within the area. The most valuable part of the published results of a soil survey is the map, generally having a scale of one inch to a mile, which portrays the extent of the different soils encountered. These maps are invaluable to anyone who wishes to know the nature of the soil at any given point. Such soil maps are generally obtainable from state agricultural experiment stations. Primarily, the United States soil surveys have been designed to be of value to farmers and to those who are helping to disseminate information to farmers.

It is claimed by some that the Russians have "put the bones and sinews" into soil science. At any rate, there has emerged from that vast land a system of soil classification that is applicable the world over. For many years the collection of taxes from the peasants in Russia has been based upon information gained from soil classification. The government has, perhaps, been more interested in soil classification than the people have. The Second International Congress of Soil Science was held in Leningrad last July, while the first was held in Washington in June, 1927. In both cases, the convention of scientists was followed by a trip throughout the country in which it was held to enable the visitors to study the soils. The Russian conception of the differentiation of soils

is that they owe their chief characteristics to the nature of the climate. "Necessarily," they say, "the soils of cold climates must differ greatly from those of hot regions, and those of humid climates from soils of arid areas." By means of the system of classification that the Russians have developed, one can confidently predict the general nature of soils that will normally be encountered in any part of the world.

### Soil Constituents.

There are four main groups of soil constituents. Upon the dominance of one or more of these groups of constituents depends the character of a soil. The nature of the climate in which the soil occurs will very largely determine which of the groups of constituents will be dominant and the condition in which these constituents will be present. The groups are: The sesquioxides of iron and aluminium; silica; the strong bases (calcium etc.); and organic carbon compounds. Let us in imagination start at the poles of the earth and work toward the equator. Beneath the polar ice sheets we do not expect to find true soils. Life in the Arctic and Antarctic polar regions is confined to the sea and to adjacent ice-clad shores. Advancing a little farther from the poles toward the equator we reach the land of the tundras, where, in summer, some inches of the surface soil may thaw out and where lichens, mosses, and a few flowering plant species exist. Some of the southern-most islands between South America or Tasmania and the South Pole, and vast stretches of northern Siberia and of northern Canada, are typical tundra regions. One hesitates to apply the name of soil to the outer layer of the crust of the earth in these regions, but at any rate it supports life and will answer to the general definition given for soils.

The next main "belt of soils" below the tundras is termed by the Russians "podzol." These soils are sometimes called "grey earths" or "forest soils." They are relatively high in silica, low in the strong bases, low in iron and aluminium, and until the final stages of leaching (or podzolization) they are quite high in semi-decomposed organic matter, which is well described by the Germans as "roh humus." These podzols occur in cool, humid climates and are generally open-textured, sandy, or gravelly soils, deficient in strong bases. They present a tri-coloured appearance.

Under Quebec conditions, the top layer (roh humus layer) is mostly semi-decomposed carbonaceous material very black in colour and of varying depth. Below the black layer appears a bleached and leached "ashes colour" layer, also of varying depth. Organic acids from the "roh humus" layer are effective solvents of soil minerals. Below this is a layer of rusty red colour, in which some of the sesquioxides leached from above have accumulated. Concretions of iron and aluminium oxides with organic matter are often present in this layer. Below the reddish layer will be found sand and gravel usually to a depth of many feet. On the North American continent the podzol belt includes a large part of the New England States, most of the south half of Quebec (although there are many "glacial till" clays of excellent fertility), northern Ontario, and there are podzol-like soils in the northern parts of the western Canadian provinces. In South America, the southern half of Argentina (part of Patagonia and Tierra del Fuego) has many podzols. Nearly one hundred years ago Charles Darwin, one of the greatest observers the human race has had, remarked the great accumulation of semi-decomposed organic matter in many of the forests of Tierra del Fuego and the light colouration of some Patagonian soils. The podzol belt soils are generally very acid. On some of the most advanced podzol soils, organic matter has almost disappeared and silica is the dominant soil constituent. Within the podzol soil belt there may occur limestone soils and other soils that are well supplied with minerals, but these are exceptional.

### "Earth Belts."

It must be understood that these vast "earth belts" of soils are very irregular in width, and that they are mixed up with each other. In the last paragraph the presence of relatively great amounts of silica and of organic matter in the soils of moist, cold climates was emphasized. Under water-logged conditions such as those met with in swamps and bogs, organic matter accumulates almost to the exclusion of the other main groups of soil-forming constituents. Throughout eastern, central, and northern Canada and in the northern United States there are many millions of acres of peat bogs, in which organic matter is distinctly dominant.

Semi-arid and arid climates have a great effect on soil conditions, whether their soils occur in hot or in cold regions. Under conditions of little rainfall the strong bases tend to accumulate. Evaporation of water from the soil exceeds rainfall, so there is little leaching. Under some arid conditions both alkali metals and alkaline earths tend to accumulate. The Russians name those arid climate soils containing alkali carbonates, "Solonetz," and others which contain neutral salts, "Solonschak."

Certain semi-arid conditions, exemplified in the great spring wheat-growing districts of the western United States and Canada, are such that organic matter can accumulate in the soils to a considerable extent. In warmer climate, semi-arid regions, and where there is more even distribution of rainfall throughout the summer, the lack of organic matter in the soils is perhaps their greatest deficiency. The black, high organic matter soils, rich in strong bases and particularly rich in calcium, are named "Tschernozem" by the Russians. These soils, found in the wheat-growing areas of Russia as well as in western America, are probably the most fertile soils in the world, although corn belt farmers, whose land lies on the eastern fringe of the North American tschernozem area, may have the right to protest at this statement.

### Effect of Arid Climate.

As a general rule it may be said that semi-arid and arid climate soils have a relatively high percentage of strong bases and are deficient in organic matter. Silica and the sesquioxides fall into the background slightly in these soils, although they are usually relatively more soluble in strongly alkaline soils of arid climates than they are in cool, humid climate soils. Intelligent application of water to arid soils results ordinarily in making possible the growing of tremendous crops. It is a striking historical fact that the most ancient civilizations were erected on arid soils. Egypt, obtaining her irrigation water from the Nile, lay on the edge of the Libyan desert. Babylon and Chaldea, Assyria, Phoenicia, and Judea all were arid climate or semi-arid climate civilizations. The fertility of desert soils, when they are given water by those who know how to apply it, is phenomenal. The important part played in soil fertility by the strong bases of the soil is at once apparent from this statement.

Farther down toward the equator than the podzol, glacial clay, and tschernozem areas, the "brown earth" soils are to be found in humid climate regions. In the United States, from Virginia southward, the soils acquire more and more of a reddish colour. This is because of their gradually increasing content of iron.

South temperate, sub-tropical, and tropical soils, under moist conditions, generally are high in iron and aluminium and (except in water-logged areas such as the Florida everglades) they usually contain less organic matter than those of colder climates. There is relatively much less silica in warm climate soils than in northern ones. Iron accumulates in these soils and so also does aluminium. The bauxite deposits of Demerara arise from this primary cause. These red-coloured warm-climate soils, which form under conditions of ample moisture supply, are called "laterites" and the process of their formation is known as "lateritization." True lateritic soils are usually ill-supplied with strong bases. In Cuba the United States, soil survey workers have studied the laterite type of soils. Bennett describes them very clearly.

The fact has been emphasized that organic matter tends to accumulate in cold humid-climate soils and tends to disappear from warm, non-swampy, humid-climate soils. This may be taken as an index of the potential "life energy" within the two kinds of soil. Tropical soils produce luxuriant jungle vegetation; this dies and becomes soil organic matter. The processes of delay are so speedy in tropical soils that organic matter quickly "fades away," due to micro-organic action, in the form of such end-products of decay as carbon dioxide and nitrate nitrogen. The carbon dioxide concentration in jungle air consequently is very high, and the nitrate nitrogen leaches away in soil drainage water in relatively great quantity.

### Tropical Soils.

While in podzols and brown earths the accumulated semi-decomposed organic matter is a source of organic acids, which profoundly modify soil conditions by their action, in ordinary well-drained moist-climate tropical soils the processes of decay are so rapid that organic matter quickly rots, producing carbon dioxide and the silica tends to leach away.

Over a very extensive zone on either side of the equator there is normally a region of very great rainfall. Next there is a band of regions of less humidity, and then a girdle of arid lands which varies much in width from north to south, and which extends right around the world. High mountain ranges and the direction of ocean currents have much to do with the extent of aridity in these lands. In the southern hemisphere the west coast of South America is arid, in Australia a great portion of the island-continent is desert land, and in South Africa the Kalahari desert exists, surrounded by semi-arid lands. In the northern hemisphere, with its greater land masses, the west central part of North America is arid or semi-arid; in Asia the desert of Gobi, the arid regions north of Tibet and Afghanistan, and the peninsula of Arabia lie in this band; in Europe the tip of Spain; in Africa the enormous extent of the Sahara desert and the aridity of Somaliland testify to the continuation of the "dry belt."

# Book Reviews.

*New Frontiers of Physics.* By PAUL R. HEYL, Ph.D. (Appleton. 6*s*.).

There have been many books of late years describing the progress and meaning of science in non-technical language. This is yet another, but an excellent one. It has the great merit of being thoroughly up to date. The author cannot be said to shrink from any difficulties in his task, and, indeed, there are many; he acquits himself every time with gratifying success. It is by no means an easy matter to retain accuracy of expression when explaining the principles of Schrödinger's wave mechanics for the benefit of the untrained reader, and the same may be said of relativity and the quantum theory. The simplicity with which attractive diagrams could be drawn of the Bohr atom probably accounts for the sudden access of popular interest in atomic physics. There appears to have been something quaintly piquant in discussing the ubiquity of those little planetary systems which, although of profoundly highbrow significance, lent themselves with such ready urbanity to dinner-table small talk. The unrelenting sternness of Newtonian physics had no such popular appeal, and it may be that, with the advent of a new conception of the atom, which admits of very little picturesque treatment, there will be less demand for graphic dissertations.

Popular interest in science, although gratifying, is not without danger. There is the possibility that the scientists' analogies may be interpreted too literally. That certain phenomena behave *as if* there were tiny planets in atoms and that light sometimes behaves *as if* it were composed of little darts may lead to the erroneous notion that these graphic images are indeed tangible facts. The borderline of physics and speculative philosophy is becoming less and less defined. Physics is becoming more and more a mesh of mathematical conceptions. We must be careful not to convey to the laymen the idea that a new atom, for example, has been found, but rather that a new and wider mathematical treatment has become necessary in order to equate experimental experience. The book under review is good because it emphasizes this point of view, and it is interesting in as much as it describes experimental data and relates it to the development of theory. The book fully justifies its title and is confidently recommended.

V. E. PULLIN.

*The Study of Crystals.* By D. B. BRIGGS. (Dent. 4*s*.).

*The Atom.* By G. P. THOMSON. (Thornton Butterworth. 2*s*. 6*d*.).

The study of crystals has of late years become one of the most important of all branches of scientific investigation. It is a matter pertaining to physics but, like many other branches of that subject, it is of fundamental significance in the progress of the sister sciences. Investigation of crystal structure by X-rays has confirmed one of the most important theories of organic chemistry—the existence of the benzene ring, and it has also enabled the atomic arrangement in complicated molecules to be determined beyond any doubt. Engineering materials depend for their all-important physical properties upon the structure of their constituent crystals and its progressive modification. More and more, therefore, do engineers depend upon the crystal analyst to tell them about the effect of stresses upon these tiny units. Crystal structure is nature's method of preserving symmetry and regularity in her building operations. Almost all solids are crystalline; in fact, those which appear not to be probably suffer merely from under-development. Before 1912, crystallographers had to be content with the study of the external form of crystals and the measurement of the angles between the numerous facets, but thanks to the discovery of X-rays and the mathematical insight of Professor von Lane, it has now become possible to examine their internal structure and to marvel at the beauty and symmetry of the delicate atom lattice work which confers on the crystal its characteristic external form.

Mr. Briggs has written an admirable little book. It is compact and contains no irrelevant matter. He describes various types of crystals and tells of the methods which are used in examining and classifying the conventional groupings. He explains the growth of crystals and the factors which operate to differentiate their form. Two chapters are devoted to the study of crystal structure by X-rays, and it is a pity that more space was not given to this important aspect of the subject, but this small criticism must not be allowed to weigh against the merit of the book as a whole. It is a book for the amateur no less than for the scientist. In particular, the worker in X-ray crystal analysis will welcome it as a handy and concise work of reference.

The second book is a very readable and general account of atomic structure and its significance in general chemical and physical theory. Professor Thomson is a reliable authority on the subject, and writes in a most interesting manner. His description of the new wave theory of matter is clear and straightforward. The book is a valuable addition to this excellent library.

V. E. P.

*With the "Italia" to the North Pole.* By UMBERTO NOBILE. Translated by FRANK FLEETWOOD. (Allen and Unwin 15*s*.).

The interest in this book lies not only in the graphic account which it contains of the ill-fated expedition to the North Pole, but because it provides General Nobile's own explanation for the fact that he allowed himself to be rescued before his crew. The book is also valuable as affording a keen insight into the personal character of the explorer, of his gallant endurance of hardship and adversity; and many who were inclined to suspect his courage will doubtless wish, on reading the book, to accept the explanation which is offered. The report of the Inquiry Committee, held in Italy under the auspices of the Admiralty, is criticized in a preface. It is suggested that the Commission was handicapped in its judgment by invoking the testimony of a pilot officer, who some years before had been imprisoned for calumnies against General Nobile, and that of a technician who had been the explorer's competitor in airship construction and had motives for personal enmity.

An interesting account of the programme of scientific investigation is given. The oceanographical researches were of primary importance. It was first of all necessary to discover whether it was possible to carry out research from the airship without disembarking anyone. It was also necessary, of course, to reduce the weight of the apparatus to a minimum, as it was impossible to adopt instruments as heavy as those used at sea. The two fundamental problems to be solved were the sounding of the sea, and the collection of samples of sea water and the

measurement of its temperature at the same time. Nansen, with whom the author discussed the subject, assured him that even a single sounding, taken in the middle of the Arctic Ocean towards Siberia and Alaska, would be of inestimable value. Nobile concentrated his attention upon wire and acoustic soundings. For the wire soundings a satisfactory device was eventually discovered. It was a small rubber float, like a circular air cushion, on which was fixed a reel of thin steel wire, unwound by a pointed lead weight of about eight kilos, tied to the free end. As soon as the dirigible had anchored, this apparatus was lowered into the sea with a cord. By means of a very simple control, worked from the pilot cabin, the weight was then released, so that it could descend freely, dragging the wire after it. The length of the wire unwound when the weight touched the bottom and measured the depth. There were many small difficulties to be overcome, but at last the experiments made in the air and from the water itself gave satisfactory results.

The question of taking samples of sea water at different depths, and measuring their temperature, was equally long a difficulty to solve. The collector eventually chosen for use consisted of a cylindrical tube with a valve at each end which, when the apparatus was overturned, shut itself hermetically, enclosing the water that filled the tube. When the experimenter saw that the collector, which was fastened to the end of a sounding line, had reached the required depth, he himself reversed it, by dropping a little piece of metal like a blunt cone. This weight, as it slid down the wire, struck against the collector, which was overturned by the blow. A reversing thermometer was attached to the collector.

Research in terrestial magnetism was divided into two parts: magnetic measurements made during the flight, and measurements to be taken if a descent was made on the ice. The first problem was bristling with difficulties. To start with, it was necessary to find a means of determining the influence which the magnetism of the dirigible itself exercised upon the magnometers. Then a doubt arose as to whether the rapid vibrations produced by the engines, and sometimes also by the wind, would permit successful measurements at all. Eventually a compass was adopted which had already been tested on board ship during the German South Polar Expedition of 1901. The only difficulty to be overcome in connexion with making observations on the ice was that of finding a method sufficiently rapid, since it might be imprudent to remain on the pack for more than three or four hours. A dip circle was borrowed from the Carnegie Institution of Washington which seemed peculiarly adapted to the conditions under which observations were to have been made.

Research in atmospheric electricity and radioactivity appear to have been the most complete of the investigations attempted.

*The Selenium Cell.* By G. P. BARNARD. (Constable. 35*s*.).

There are several new scientific developments which depend for their success entirely on the effect of light upon the electrical properties of a cell. The most important, of course, is television and its associated phenomena, and talking films. There are two alternative courses open to the experimenter. He may use either a material like selenium which, when irradiated by light, changes its electrical resistance, and thus may be used to record variations in the intensity of the illuminant, or he may use what is known as a photo-electric cell, of which several different patterns are available commercially. In some cases, for example, talking films and television, the selenium cell has probably certain advantages. This curious property of selenium was discovered in 1873. Since then it has been used and studied in diverse ways by many observers, so that the resulting literature on the subject is profuse and scattered.

Mr. Barnard deserves the thanks of all scientific workers for this excellent compilation of knowledge concerning selenium. Much that he describes is his own work, but he has certainly omitted nothing of any value that has been done by others. It will become the standard work of reference on the subject. The book is divided into two parts, the first being devoted to the properties of the element, together with an account of the theories of the action of light on selenium and a description of the construction of the various forms of cell. The second part is concerned with the numerous applications of selenium, both historical and present day. A remarkably complete bibliography is provided at the end of each chapter. There are valuable appendices in which are tabulated all the physical, chemical, electrical and optical constants of selenium and a list of the tests appropriate to the cells. Incidentally, in the second part of the book, the author describes in a very full and interesting manner the various methods and systems employed in television, talking films, light telephony and so on. This section of the book will therefore be found of considerable popular interest. The whole constitutes a valuable work of instruction and reference for the scientific man. The diagrams are profuse and excellent and the printing and arrangement of the book is good.

V. E. P.

*The Living Past.* By John C. MERRIAM. (Scribners. 7*s*. 6*d*.).

In the region known as Rancho La Brea, in California, there is an extensive swamp of asphalt which has poured from the ground in springs for thousands of years. Investigations have revealed the fact that the swamp contains the remains of prehistoric animals, as was described in a recent article in *Discovery*. The creatures had ventured on to the asphalt and had been engulfed. Their discovery has led to extended scientific investigations, involving excavation of the asphalt pools and reassembling of the skeletons unearthed. A vast amount of material has been brought to light which has been estimated at approximately three million bones. Not only is the material perfectly conserved, but there is interesting evidence of the mode of life of the animals represented.

These investigations are among several episodes in archaeological research described in this diverting little book by Mr. Merriam, who is President of the Carnegie Institution, Washington. Geological and anthropological discoveries which he has conducted are reviewed, and their significance in what he terms the history of life is explained. Other chapters are entitled "The Meaning of a Fragment," "The Story of a Leaf," "An Abyss in Time," and "Footprints on the Path of History." One of the early excavations at Rancho La Brea revealed the skull of an ancient tiger.

In the great number of beasts entombed in the asphalt lake, a large percentage are of types no longer living in any part of the earth. Many of these have their nearest relatives in the life of still earlier ages; such are the sabre-tooth, mastodon, ground sloth and many others. The elephant, camel, and horse have, of course, close relatives living to-day in other continents. With these two groups are other species, such as the coyote and puma, the rodents and many birds and plants which intimately resemble animals to be found in California to-day.

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